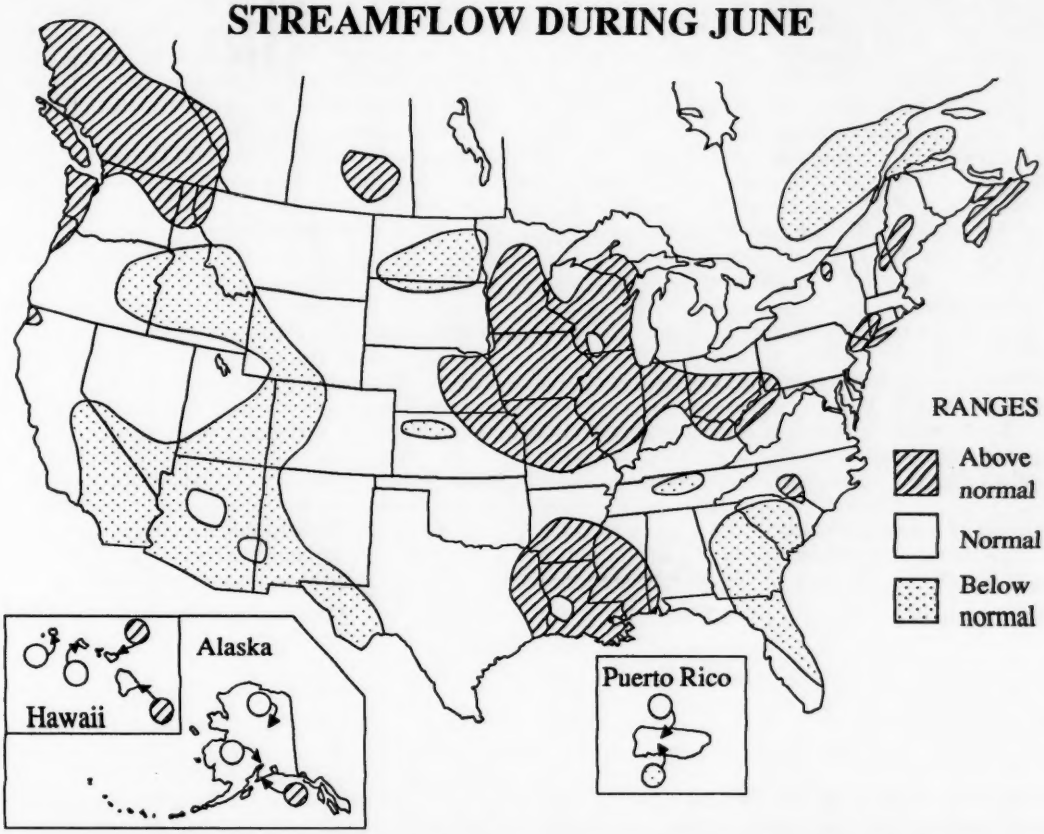
National Water Conditions

UNITED STATES
Department of the Interior
Geological Survey

CANADA
Department of the Environment
Water Resources Branch

JUNE 1990

STREAMFLOW DURING JUNE



Heavy rains caused severe floods in parts of Nebraska, Iowa, and Ohio. The most damaging floods occurred on Wegee and Pipe Creeks, Belmont County, Ohio, where 26 people were killed, and 1,200 homes and trailers were destroyed. Peak discharges exceeded those of record or the 100-year flood at 13 stations in the 3 States.

Streamflow was in the normal to above-normal range at 81 percent of the index stations in southern Canada, the United States, and Puerto Rico during June, compared with 74 percent of stations in those ranges during May. Below-normal range streamflow occurred in 19 percent of the area of southern Canada and the conterminous United States during June compared with 28 percent during May. Total flow for the index stations in the conterminous United States and southern Canada was 40 percent above median.

The combined flow of the 3 largest rivers in the lower 48 States—Mississippi, St. Lawrence, and Columbia—averaged 29 percent above median and in the above-normal range during June, 11 percent more than during May.

Monthend index reservoir contents for June 1990 were in the below-average range at 39 of 100 reporting sites, including most reservoirs in Nebraska, the Dakotas, Wyoming, Idaho, Utah, Nevada, and California.

Mean June elevations at the four master gages on the Great Lakes (provisional National Ocean Service data) were in the below-normal range on Lake Superior and in the normal range on Lakes Huron, Erie, and Ontario.

Utah's Great Salt Lake fell 0.30 foot to 4,204.00 feet above National Geodetic Vertical Datum of 1929 during the month as lake level continued to decline seasonally.

SURFACE-WATER CONDITIONS DURING JUNE 1990

Heavy rains caused severe floods in parts of Nebraska, Iowa, and Ohio. (See maps and tables on pages 4-5.) Peak discharges at some streamflow stations exceeded those for the 100-year flood and peaks of record. Flooding also occurred in other areas, including Nevada, where two people were killed, but no peaks of record were reported.

On June 10, heavy rains caused flash floods in Las Vegas, Nevada. Two people were killed and damages to homes and roads were estimated at $2.6 million. Flood frequencies were 25 years or less.

On June 14-15 severe floods occurred in Jefferson, Belmont, and Harrison Counties, Ohio, an area adjacent to the northern West Virginia panhandle. The most damaging floods occurred on Wegee and Pipe Creeks, Belmont County, where 26 people were killed, and 1,200 homes and trailers were destroyed. About 3-5 inches of rain falling in a 3-hour period on the evening of June 14 caused the floods. Both creeks have drainage areas of about 13 square miles, run through steep and narrow valleys, and drain directly into the Ohio River. In Harrison and Jefferson Counties, floods on Short Creek and its tributaries caused damages in towns along the streams. Peak discharge at the streamflow station Short Creek near Dillonvale exceeded that for the 100-year flood and the previous peak of record. The previous peak of record on Wheeling Creek below Blaine was also exceeded, but the recurrence interval has not been determined. Peak discharges of other streams in the area had recurrence intervals of about 2 years.

Rainfall of up to 11 inches in a 4-day period, June 13-16, fell in northeastern Nebraska causing major flooding in the Shell Creek, Maple Creek, and Union Creek basins. Lesser flooding occurred along the Elkhorn River from Norfolk downstream to the mouth. Peak discharges exceeded those for the period of record and also equaled or exceeded the 100-year recurrence interval at two stations: on June 17, at Shell Creek near Columbus, and on June 16, at Union Creek at Madison. Peak discharges at Pebble Creek at Scribner and Maple Creek near Nickerson had recurrence intervals of about 50 years. The State declared six counties—Platte, Colfax, Dodge, Madison, Stanton, and Cuming—disaster areas. Over 180,000 acres of farmland were flooded and damages were estimated as being over $50 million for the six hardest-hit counties. One death was attributed to the flooding.

On June 17-22 severe flooding caused by heavy rains occurred in parts of Iowa. Forty-one counties were declared disaster areas by the State and 18 were declared eligible for federal assistance. Damage estimates exceeded $83 million. Two people were killed. Peak discharges exceeded both those of record and the hundred-year recurrence interval at five gaging stations on June 17: Wapsipinicon River near DeWitt in east-central Iowa; Clear Creek near Coralville in east-central Iowa; Squaw Creek at Ames in central Iowa; North River near Norwalk in central Iowa; and South River near Ackworth in central Iowa. Recurrence intervals for peaks at other stations were 2-50 years.

Since much of June's rains fell in areas which were already wet, drought conditions continued in parts of the West and Southeast.

In California, contents of 8 of 9 index reservoirs were well-below monthend averages for June, and, at 7 of those 8, well-below those at the end of June 1989.

In the Dakotas, contents of the two largest reservoirs, Lake Sakakawea (North Dakota) and Lake Oahe (South Dakota), were well-below monthend averages for June, and at or below June 1989 levels.

In Florida, water-use restrictions, imposed by the St. Johns River Water Management District, were in effect in 12 counties as of May 30: Seminole, Volusia, Marion, Flagler, St. Johns, Clay, Nassau, Duval, Bradford, Putnam, Baker, and Alachua. Voluntary water-use restriction has been called for in Orange, northern Osceola, Brevard, Lake, Polk, Indian River, and Okeechobee counties.

Streamflow was in the normal to above-normal range at 81 percent of the index stations in southern Canada, the United States, and Puerto Rico during June, compared with 74 percent of stations in those ranges during May, and 73 percent of stations in those ranges during June 1989. Below-normal range streamflow occurred in 19 percent of the

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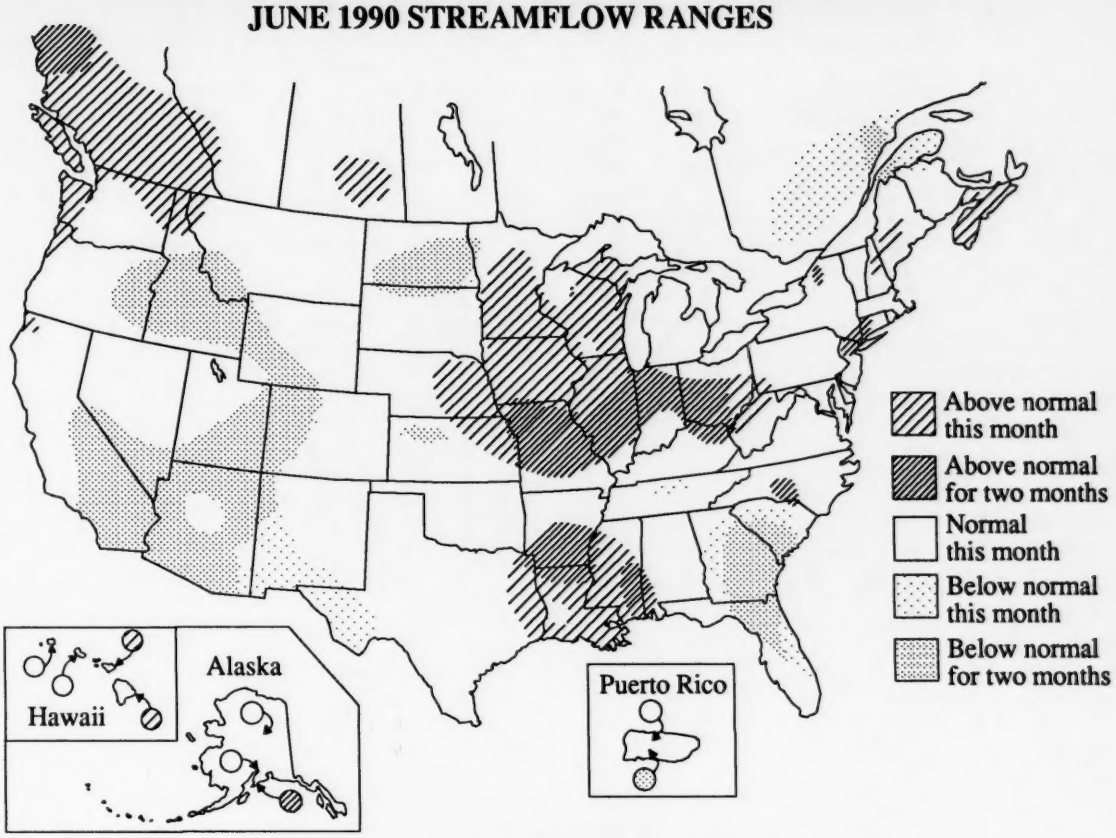
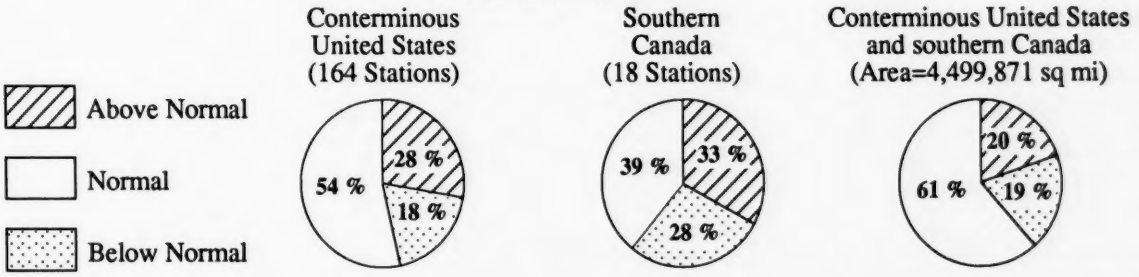
JUNE 1990 STREAMFLOW RANGES

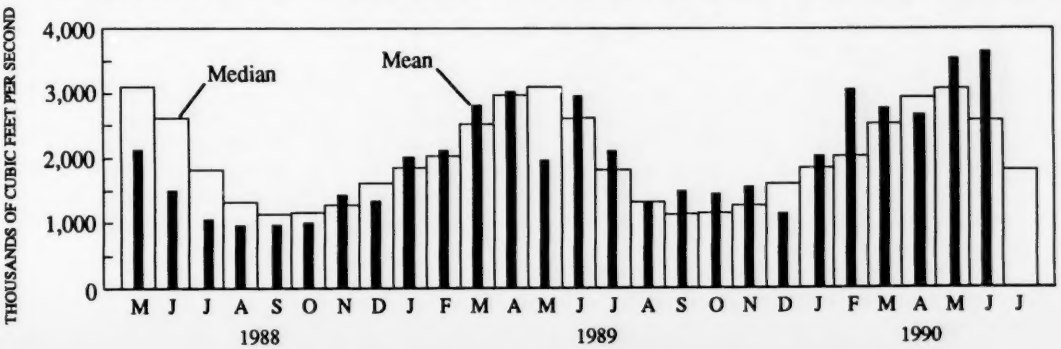


SUMMARY OF JUNE 1990 STREAMFLOW

FLOW RANGES

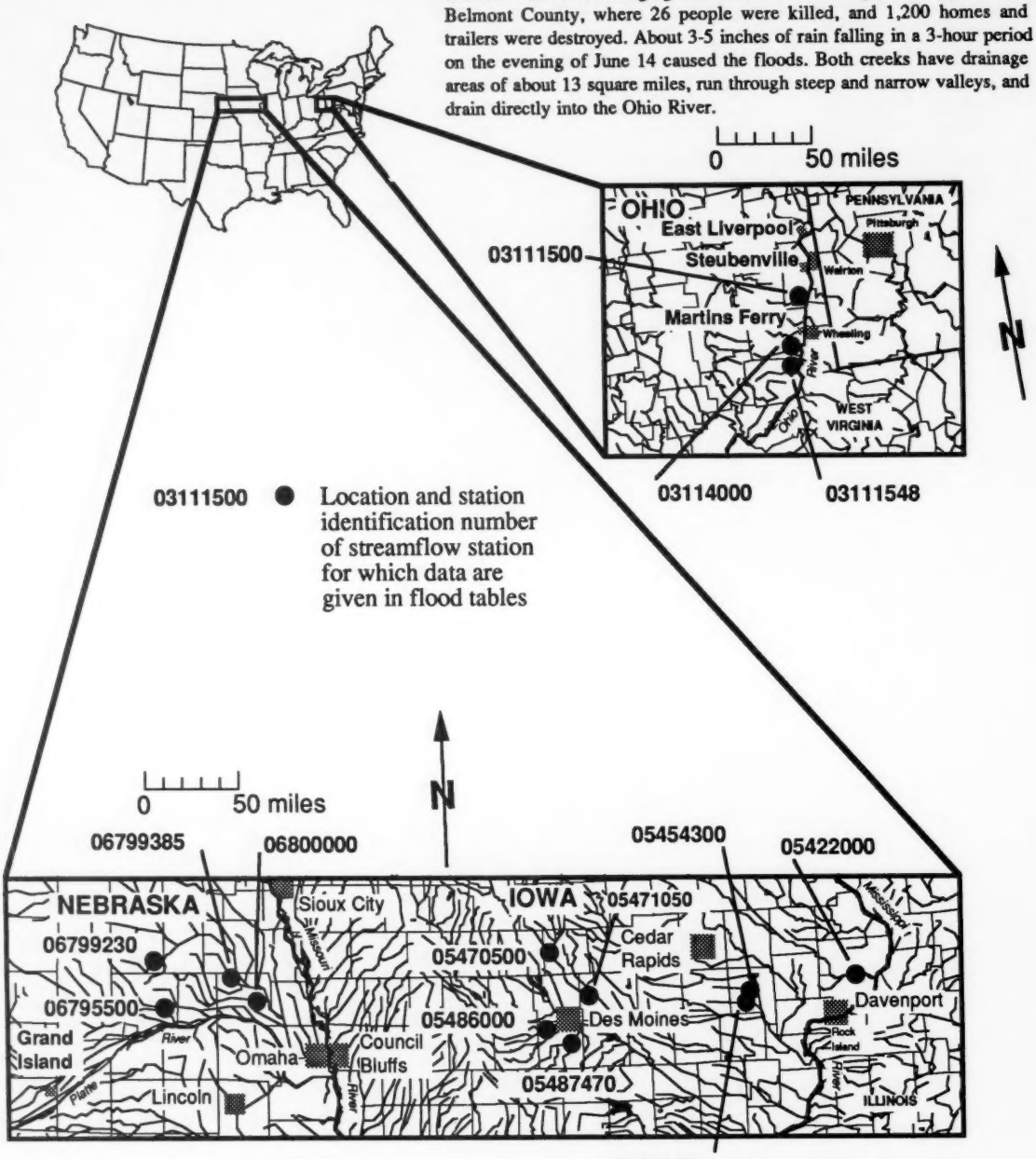


COMPARISON OF TOTAL MONTHLY MEANS WITH TOTAL MONTHLY MEDIANS



FLOODS IN OHIO, IOWA, AND NEBRASKA DURING JUNE 1990

OHIO.--The most damaging floods occurred on Wegee and Pipe Creeks, Belmont County, where 26 people were killed, and 1,200 homes and trailers were destroyed. About 3-5 inches of rain falling in a 3-hour period on the evening of June 14 caused the floods. Both creeks have drainage areas of about 13 square miles, run through steep and narrow valleys, and drain directly into the Ohio River.



NEBRASKA.--Rainfall of up to 11 inches in a 4-day period, June 13-16, fell in northeastern Nebraska causing major flooding in the Shell Creek, Maple Creek, and Union Creek basins. Lesser flooding occurred along the Elkhorn River from Norfolk downstream to the mouth. The State declared six counties—Platte, Colfax, Dodge, Madison, Stanton, and Cuming—disaster areas. Over 180,000 acres of farmland were flooded and damages were estimated as being over $50 million for the six hardest-hit counties. One death was attributed to the flooding.

IOWA.--Forty-one counties were declared disaster areas by the State and 18 were declared eligible for federal assistance. Damage estimates exceeded $83 million. Two people were killed. Peak discharges exceeded both those of record and the hundred-year recurrence interval at five gaging stations June 17-22.

Provisional data; subject to revision

FLOOD DATA FOR SELECTED SITES IN OHIO JUNE 1990

WRD Station number	Stream and place of determination	Drainage area (square miles)	Period of known floods	Maximum flood previously known: Date	Stage (feet)	Discharge (cfs)	Maximum during present flood: Discharge: Date	Stage (feet)	Cfs	Cfs per square mile	Recurrence interval (years)
	SHORT CREEK BASIN										
03111500	Short Creek near Dillonvale	123	1941-	March 6, 1945 March 5, 1963	8.77 10.15	6,500	June 15	12.27	8,500	61.0	[a]1.16
	CAPTINA CREEK BASIN										
03114000	Captina Creek at Armstrongs Mills	134	1926-1935 1958-	August 11, 1980	17.48	21,900	14	10.05	6,010	44.8	[b]
	WHEELING CREEK BASIN										
03111548	Wheeling Creek below Blaine	97.7	1982-1987, 1988-	June 21, 1989	6.85	3,780	15	7.63	4,720	48.3	[c]

[a] Recurrence interval greater than 100 years. Value shown is approximate ratio of discharge to that of 100-year flood.
[b] Recurrence interval less than 2 years.
[c] Recurrence interval less than 10 years, but not determined.

Provisional data; subject to revision

FLOOD DATA FOR SELECTED SITES IN IOWA JUNE 1990

WRD Station number	Stream and place of determination	Drainage area (square miles)	Period of known floods	Maximum flood previously known: Date	Stage (feet)	Discharge (cfs)	Maximum during present flood: Discharge: Date	Stage (feet)	Cfs	Cfs per square mile	Recurrence interval (years)
	WAPSIPINICON RIVER BASIN										
05422000	Wapsipinicon River near DeWitt	2,330	1934-	May 17, 1974	13.07	29,900	June 17	14.20	33,400	14.3	[a]1.07
	IOWA RIVER BASIN										
05454300	Clear Creek near Coralville	98.1	1952-	June 15,1982	14.61	9,900	17	16.36	11,000	112	[a]1.08
05455100	Old Mans Creek near Iowa City	201	1951-64 1985-	May 29,1962	16.52	12,000	17	17.57	14,200	70.6	50
	SKUNK RIVER BASIN										
05470500	Squaw Creek at Ames	204	1919-27 1965-	June 27, 1975	14.00	11,300	17	15.55	11,400	55.9	[a]1.44
05471050	South Skunk River at Colfax	803	1985-	August 27, 1987	17.35	6,850	22	19.02	9,940	12.4	[b]
	DES MOINES RIVER BASIN										
05486000	North River near Norwalk	349	1940-	June 13, 1947	25.3	32,000	17	25.34	29,000	83.1	[a]1.40
05487470	South River near Ackworth	460	1940-	June 5, 1947	24.60	34,000	17	32.88	39,000	84.8	[a]1.21

[a] Recurrence interval greater than 100 years. Value shown is approximate ratio of discharge to that of 100-year flood.
[b] Not determined.

Provisional data; subject to revision

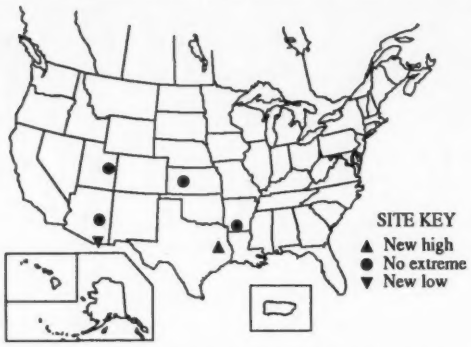
FLOOD DATA FOR SELECTED SITES IN NEBRASKA JUNE 1990

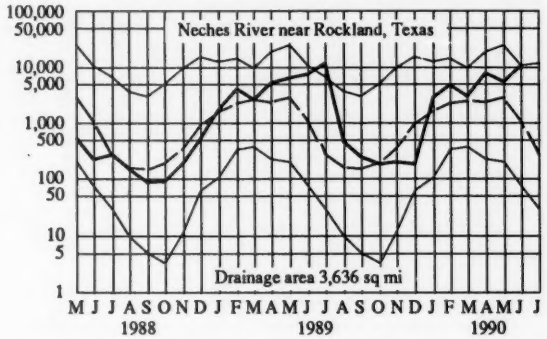
WRD Station number	Stream and place of determination	Drainage area (square miles)	Period of known floods	Maximum flood previously known: Date	Stage (feet)	Discharge (cfs)	Maximum during present flood: Discharge: Date	Stage (feet)	Cfs	Cfs per square mile	Recurrence interval (years)
	PLATTE RIVER BASIN										
06795500	Shell Creek near Columbus	270	1947-75 1977-	June 3, 1950	21.38	5,970	17	22.76	8,000	29.6	100
06799230	Union Creek at Madison	174	1978-	June 17, 1984	22.90	7,630	16	28.55	30,000	172	[a]1.5
06799385	Pebble Creek at Scribner	204	1978-	June 16, 1984	23.75	20,300	17	23.91	22,700	111	50
06800000	Maple Creek near Nickerson	450	1951-	June 21, 1960 June 17, 1984 June 11, 1944	14.67 17.65 [b]	10,800 [b] [c]35,000	17	16.30	11,600	25.8	50

[a] Recurrence interval greater than 100 years. Value shown is approximate ratio of discharge to that of 100-year flood.
[b] Not determined.
[c] Outside period of record.

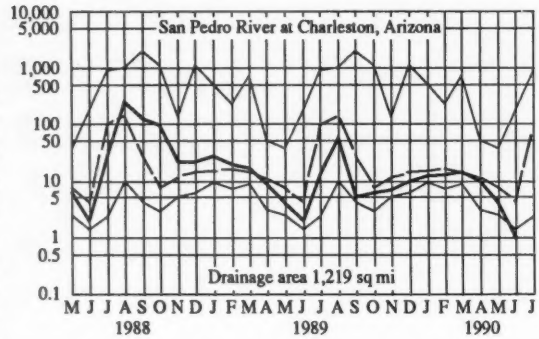
MONTHLY MEAN DISCHARGE OF SELECTED STREAMS

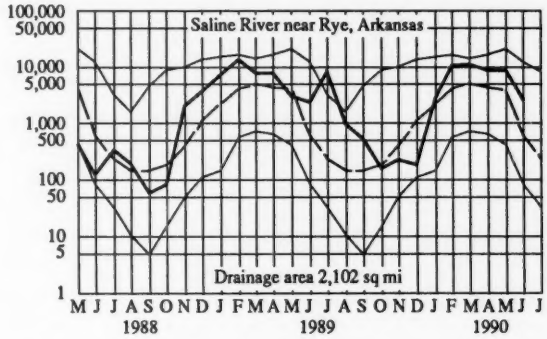
Area between light-weight solid lines indicates range between highest and lowest record for the month. Dashed line indicates median of monthly values for reference period, 1951-80. Heavy line indicates mean for current period.

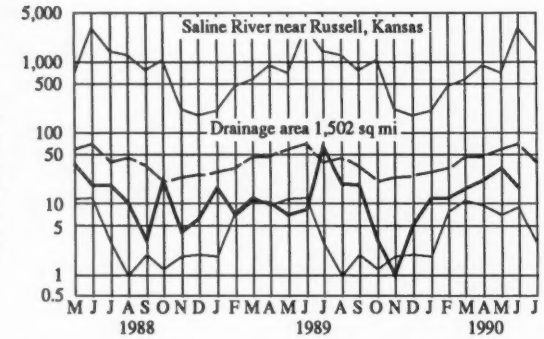


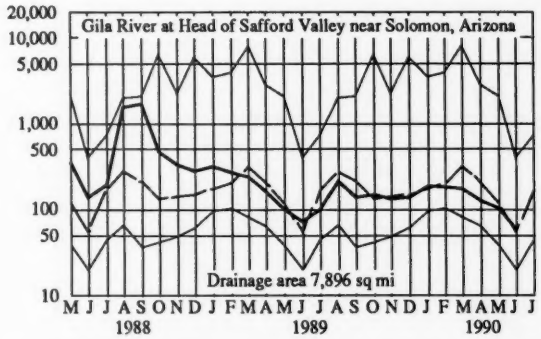


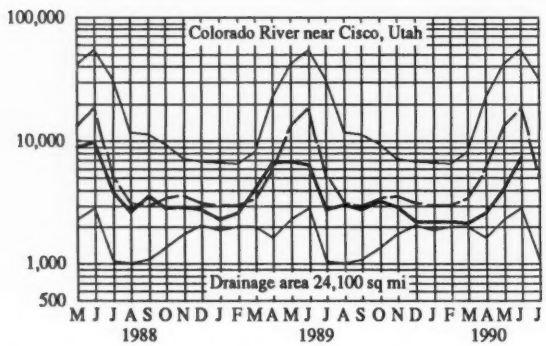
DISCHARGE IN CUBIC FEET PER SECOND










Colorado River near Cisco, Utah
Drainage area 24,100 sq mi
100,000
10,000
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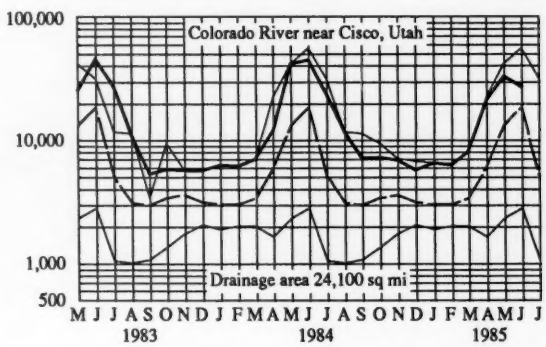
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1983
1984
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area of southern Canada and the conterminous United States during June compared with 28 percent during May and 28 percent during June 1989. Total June 1990 flow of 3,637,100 cubic feet per second (cfs) for the index stations in the conterminous United States and southern Canada was 40 percent above median after a 3 percent increase in streamflow from May to June, and 23 percent more than flow during June 1989.

Two new monthly extremes, one low and one high, occurred at streamflow index stations during June compared with seven new extremes, three lows and four highs, during May. The new low was in Arizona, where the monthly mean discharge of 1.33 cfs on the San Pedro River at Charleston set an all-time low for that station, and the daily mean discharge of 0.29 cfs on June 27 was a new low for the month. The monthly mean was 6 percent less than the previous all-time low of 1.41 cfs, set in June 1982, while the minimum daily mean was 36 percent lower than that of June 1974, 0.80 cfs. The new high was in Texas, where the monthly mean discharge of 10,440 cfs on the Neches River near Rockland set a June high for that station, exceeding the 10,250 cfs of June 1973 by 2 percent. Hydrographs for the 2 index stations at which new extremes occurred and 5 others are shown on page 6. Three of the other five hydrographs are for streams where flow conditions have persisted the longest in the specified flow range as of this month: Saline River near Russell, Kansas, where streamflow has been in the below-normal range for nine consecutive months; Saline River near Rye, Arkansas, where streamflow has been in the above-normal range for 5 months; Gila River at Head of Safford Valley near Solomon, Arizona, where streamflow has been in the normal range for 19 months. The last 2 hydrographs are both for the Colorado River near Cisco, Utah, where streamflow has been in the below-normal range for 8 months as of the end of June 1990. The first hydrograph for this stream is for the 26-month period ending June 1990 and the second hydrograph is for a 26-month period ending June 1985. During the earlier period, flow conditions were quite different from the present. As of June 1985, flow of the Colorado River near Cisco had been in the above-normal range for 26 months, and continued in that range through May 1986. The monthly mean for each month from November 1984 through March 1985 was a record high for the month, exceeding the monthly highs for December through March set during the 1984 water year. (Monthly means for May and August 1984 were also the highest of record.) The December and February record highs set in the 1985 water year were exceeded in turn in the 1986 water year. Only the highs for the months of October, April, June, July, and September occurred other than during the 1984-87 water years.

The combined flow of the 3 largest rivers in the lower 48 States—Mississippi, St. Lawrence, and Columbia—averaged 1,929,100 cfs (29 percent above median and in the above-normal range) during June, 11 percent more than during May. Flow of the St. Lawrence River was in the normal range for the fourth consecutive month. Flow of the Mississippi River was in the above-normal range for the second consecutive month, and flow of the Columbia River was in the normal range after a below-normal-range May. Hydrographs for both the combined and individual flows of the "Big 3" are on page 8. Dissolved solids and water temperatures at five large river stations are also given on page 8. Flow data for the "Big 3" and 42 other large rivers are given in the Flow of Large Rivers table on page 9.

Monthend index reservoir contents for June 1990 were in the below-average range (below the monthend average for the period of record by more than 5 percent of normal maximum contents) at 39 of 100 reporting sites, compared with 33 of 100 during May, including most reservoirs in Nebraska, the Dakotas, Wyoming, Idaho, Utah, Nevada, and California. Contents were in the above-average range at 27 reservoirs (compared with 32 last month), including most reservoirs in Nova Scotia, Maine, Maryland, South Carolina, the Tennessee Valley, Minnesota, Oklahoma, and Texas. Reservoirs with contents in the below-average range and significantly lower than last year (with normal maximum contents of at least 1,000,000 acre-feet) were: International Amistad and International Falcon, Texas; Lake McConaughy, Nebraska; Fort Peck, Montana; Boise River (4 reservoirs), Idaho; the Pathfinder and associated reservoirs, Wyoming; Bear Lake, Idaho-Utah; Folsom Lake, Clair Engle Lake, Lake Berryessa and Shasta Lake, California; the Salt and Verde River System, Arizona; and also the Colorado River Storage Project. Graphs of contents for seven reservoirs are shown on page 10 with contents for the 100 reporting reservoirs given on page 11.

Streamflow conditions during June 1990 and June 1989 are shown by maps on page 12. There is about one-third as much area in the below-normal range during June 1990 as there was during June 1989. Total area in the above-normal range during June 1990 is about 30 percent more than during June 1989. Parts of the Gulf Coast States, Great Lakes States, and Atlantic Coast States have streamflow in the above-normal range during both months. In the West and Southeast, large areas have below-normal range streamflow during both months. The locations of reservoirs with below-average contents at the end of June 1990 and June 1989 are also shown on the respective maps.

Mean June elevations at the four master gages on the Great Lakes (provisional National Ocean Service data) were in the below-normal range on Lake Superior and in the normal range on Lake Huron, Lake Erie, and Lake Ontario. Levels rose from those for May on all four lakes. June 1990 levels ranged from 0.07 foot (Lake Erie) to 0.31 foot higher (Lake Huron) than those for May. Monthly means have now been in the below-normal range for 9 months on Lake Superior. Monthly means have been in the normal range for 1 month on Lake Huron (after 1 month in the below-normal range), for 27 months on Lake Erie and 14 months on Lake Ontario. June 1990 levels ranged from 0.25 foot (Lake Ontario) to 0.82 foot lower (Lake Superior) than those for June 1989. Stage hydrographs for the master gages on Lake Superior, Lake Huron, Lake Erie, and Lake Ontario are on page 13.

Utah's Great Salt Lake (graph on page 13) fell 0.30 foot to 4,204.00 feet above National Geodetic Vertical Datum (NGVD) of 1929 in June as lake level continued to decline seasonally after peaking at 4,204.70 feet above NGVD of 1929 in March-April. Lake level is 2.00 feet lower than at the end of June 1989, and 7.85 feet lower than the maximum of record which occurred in June 1986 and March-April 1987.

Streamflow conditions in 5 areas affected by drought in 1988-89 (California, Pacific Northwest, Northern Great Plains, Western Great Lakes, and Southeast) are shown by graphs on page 14. June streamflow was above median except in California and the Pacific Northwest.

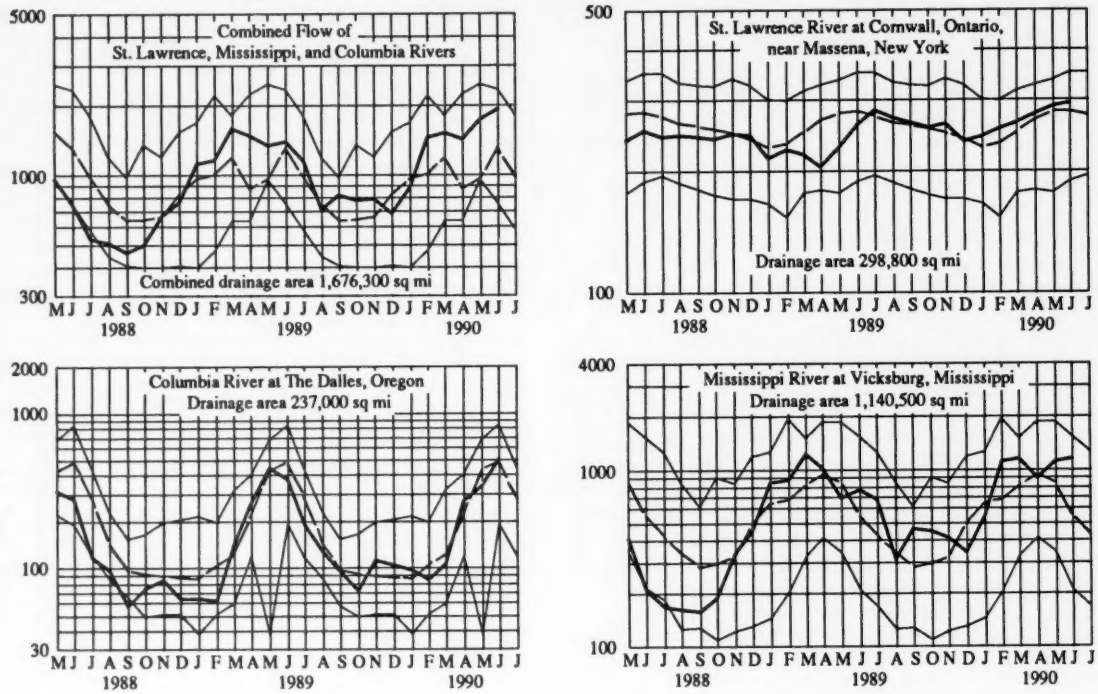
Streamflow conditions during Spring (April 1-June 30) 1990 and Spring 1989 are shown by maps on page 15. There is almost 50 percent more area in the below-normal range during Spring 1990 than during Spring 1989. Total area in the above-normal range during 1990 is about the same as during 1989. Parts of the Gulf Coast States, Great Lakes States, and Atlantic Coast States have streamflow in the above-normal range during both periods. West of the Mississippi River, large areas have below-normal range streamflow during both periods.

The Palmer Drought Severity maps for June 9 and 23, 1990 (page 18), show an increase in the area of both severe and extreme drought west of the Mississippi River June 9-23. An area of severe to extreme drought in southern Florida remains about the same size shown since April 28. An area of moderate to severe drought in northeastern Wisconsin and northern Michigan has varied in size and severity but has also persisted since April 28. The area of severe to extreme drought in the Dakotas and parts of adjacent Montana and Minnesota has also persisted, although varying in size and severity, since April 28.

HYDROGRAPHS FOR THE "BIG THREE" RIVERS

Area between light-weight solid lines indicates range between highest and lowest record for the month. Dashed line indicates median of monthly values for reference period, 1951-80. Heavy line indicates mean for current period.

DISCHARGE, IN THOUSAND CUBIC FEET PER SECOND



Provisional data; subject to revision

DISSOLVED SOLIDS AND WATER TEMPERATURES, FOR JUNE 1990, AT DOWNSTREAM SITES ON FIVE LARGE RIVERS

Station number	Station name	June data of following calendar years	Stream discharge during month	Dissolved-solids concentration[a]		Dissolved-solids discharge[a]			Water temperature[b]		
			Mean (cfs)	Minimum (mg/L)	Maximum (mg/L)	Mean	Minimum (tons per day)	Maximum	Mean in °C	Minimum in °C	Maximum in °C
01463500	Delaware River at Trenton,	1990	9,820	86	120	2,760	1,780	5,420	22.0	17.0	26.5
	New Jersey, (Morrisville,	1945-89	9,730	60	143	2,780[d]	495	22,100	22.5[d]	13.5	34.0
	Pennsylvania)	(Extreme yr)		(1945)	(1965)		(1965)	(1973)			
			[c]7,176								
07289000	Mississippi River at	1990	1,140,000	193	224	626,000	458,000	739,000	26.0	23.0	28.5
	Vicksburg, Mississippi	1976-89	632,000	176	330	350,000	34,400	837,000	25.5	17.0	31.0
		(Extreme yr)		(1981)	(1988)		(1978)	(1984)			
			[c]546,500								
03612500	Ohio River at lock and dam 53,	1990	371,000	159	202	.....	57,000	343,000	...	19.0	26.0
	near Grand Chain, Illinois,	1955-89	218,000	111	300	.....	27,000	731,000	...	16.5	30.5
	(streamflow station at Metropolis,	(Extreme yr)		(1974)	(1970)		(1977)	(1983)			
	Illinois)		[c]175,700								
06934500	Missouri River at Hermann,	1990	183,000	247	375	150,000	93,300	214,000	23.0	19.0	28.0
	Missouri. (60 miles west of	1976-89	113,080	207	499	103,000	44,000	215,000	24.5	19.0	29.5
	St. Louis, Missouri)	(Extreme yr)		(1977)	(1988)		(1977)	(1984)			
			[c]86,260								
14128910	Columbia River at Warrendale,	1990	307,000	77	83	66,300	50,600	80,400	16.0	14.5	18.0
	Oregon (streamflow station at	1976-89	248,000	61	107	53,500	19,100	103,000	16.0	12.5	19.5
	The Dalles, Oregon)	(Extreme yr)		(1976)	(1977)		(1977)	(1983)			
			[c]481,150								

[a]Dissolved-solids concentrations, when not analyzed directly, are calculated on basis of measurements of specific conductance.
[b]To convert °C to °F: [(1.8 x °C) + 32] = °F.
[c]Median of monthly values for 30-year reference period, water years 1951-80, for comparison with data for current month.
[d]Mean for 6-year period (1984-89).

Provisional data; subject to revision

FLOW OF LARGE RIVERS DURING JUNE 1990

Station number	Stream and place of determination	Drainage area (square miles)	Average discharge through September 1985 (cubic feet per second)	June 1990					
				Monthly mean discharge (cubic feet per second)	Percent of median monthly discharge 1951–80	Change in discharge from previous month (percent)	Discharge near end of month		
							Cubic feet per second	Million gallons per day	Date
01014000	St. John River below Fish River at Fort Kent, Maine	5,665	9,758	10,100	107	–56	7,380	4,770	30
01318500	Hudson River at Hadley, New York	1,664	2,908	2,570	124	–68	1,250	807	30
01357500	Mohawk River at Cohoes, New York	3,456	5,683	2,410	91	–82	1,500	970	30
01463500	Delaware River at Trenton, New Jersey	6,780	11,670	9,820	137	–55	5,620	3,630	30
01570500	Susquehanna River at Harrisburg, Pennsylvania	24,100	34,340	25,300	136	–48	12,700	8,210	27
01646500	Potomac River near Washington, District of Columbia	11,560	[1]11,500	[1]10,200	134	–22	3,570	2,310	30
02105500	Cape Fear River at William O. Huske Lock, near Tarheel, North Carolina.	4,852	5,002	2,650	104	–56	.....	.....	...
02131000	Pee Dee River at Peedee, South Carolina	8,830	9,871	10,500	137	–14	4,500	2,910	30
02226000	Altamaha River at Doctortown, Georgia	13,600	13,730	4,110	54	–36	2,840	1,840	29
02320500	Suwannee River at Branford, Florida	7,880	6,986	2,360	45	–28	2,070	1,340	30
02358000	Apalachicola River at Chattahoochee, Florida	17,200	22,420	16,400	102	–4	14,000	9,000	30
02467000	Tombigbee River at Demopolis lock and dam, near Coatopa, Alabama.	15,385	23,520	11,500	157	–43	4,200	2,710	30
02489500	Pearl River near Bogalusa, Louisiana	6,573	9,880	13,000	328	–24	4,870	3,150	30
03049500	Allegheny River at Natrona, Pennsylvania	11,410	[1]19,580	[1]11,800	126	–57	7,300	4,720	25
03085000	Monongahela River at Braddock, Pennsylvania	7,337	[1]12,480	[1]11,300	189	–32	4,040	2,610	25
03193000	Kanawha River at Kanawha Falls, West Virginia	8,367	12,550	10,100	144	–37	4,030	2,600	30
03234500	Scioto River at Higby, Ohio	5,131	4,583	10,500	348	–35	2,400	1,550	29
03294500	Ohio River at Louisville, Kentucky[2]	91,170	115,800	175,000	278	–24	72,400	46,800	25
03377500	Wabash River at Mount Carmel, Illinois	28,635	27,660	46,700	227	–50	24,900	16,090	30
03469000	French Broad River below Douglas Dam, Tennessee	4,543	[1]6,739	3,850	72	–58	.....	.....	...
04084500	Fox River at Rapide Croche Dam, near Wrightstown, Wisconsin.[2]	6,010	4,238	8,370	229	36	10,500	6,760	30
04264331	St. Lawrence River at Cornwall, Ontario, near Massena, New York.[3]	298,800	243,900	294,000	105	2	285,000	184,000	30
02NG001	St. Maurice River at Grand Mere, Quebec	16,300	24,910	21,000	71	–67	17,500	11,300	28
05082500	Red River of the North at Grand Forks, North Dakota	30,100	2,593	2,090	50	47	1,800	1,160	30
05133500	Rainy River at Manitou Rapids, Minnesota	19,400	12,920	28,700	139	40	28,800	18,600	26
05330000	Minnesota River near Jordan, Minnesota	16,200	3,680	8,870	155	213	14,600	9,440	30
05331000	Mississippi River at St. Paul, Minnesota	36,800	[1]11,020	25,300	150	88	32,000	20,700	30
05365500	Chippewa River at Chippewa Falls, Wisconsin	5,650	5,149	6,780	129	–20	3,600	2,330	30
05407000	Wisconsin River at Muscoda, Wisconsin	10,400	8,710	15,200	154	30	17,700	11,400	30
05446500	Rock River near Joslin, Illinois	9,549	6,080	8,590	148	6	23,100	14,900	30
05474500	Mississippi River at Keokuk, Iowa	119,000	63,790	148,000	174	46	172,000	111,000	30
06214500	Yellowstone River at Billings, Montana	11,795	7,056	22,400	77	123	24,600	15,900	30
06934500	Missouri River at Hermann, Missouri	524,200	80,880	183,000	212	–6	133,000	86,000	30
07289000	Mississippi River at Vicksburg, Mississippi[4]	1,140,500	584,000	1,140,000	209	2	894,000	578,000	25
07331000	Washita River near Dickson, Oklahoma	7,202	1,402	2,690	195	–83	2,350	1,520	29
08276500	Rio Grande below Taos Junction Bridge, near Taos, New Mexico.	9,730	742	572	79	–36	391	252	30
09315000	Green River at Green River, Utah	44,850	6,391	7,110	42	73	.....	.....	...
11425500	Sacramento River at Verona, California	21,251	19,430	9,310	82	–9	.....	.....	...
13269000	Snake River at Weiser, Idaho	69,200	18,520	13,000	54	17	7,050	4,560	30
13317000	Salmon River at White Bird, Idaho	13,550	11,390	21,300	50	28	14,400	9,310	30
13342500	Clearwater River at Spalding, Idaho	9,570	15,510	32,000	79	–9	13,200	8,530	30
14105700	Columbia River at The Dalles, Oregon[5]	237,000	[1]193,500	[1]493,100	102	49	261,000	169,000	30
14191000	Willamette River at Salem, Oregon	7,280	[1]23,690	[1]16,400	136	–11	7,540	4,870	30
15515500	Tanana River at Nenana, Alaska	25,600	23,810	56,800	122	70	53,000	34,300	30
08MF005	Fraser River at Hope, British Columbia	83,800	96,250	310,000	125	75	300,000	194,000	29

[1]Adjusted.

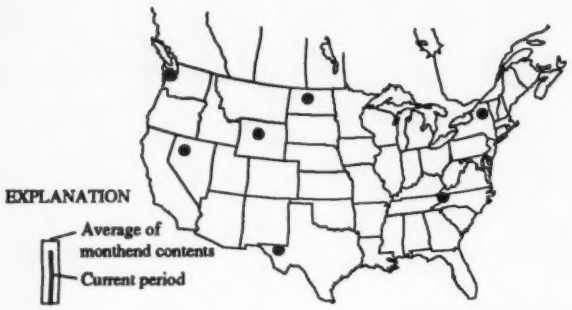
[2]Records furnished by Corps of Engineers.

[3]Records furnished by Buffalo District, Corps of Engineers, through International St. Lawrence River Board of Control. Discharges shown are considered to be the same as discharge at Ogdensburg, N.Y., when adjusted for storage in Lake St. Lawrence.

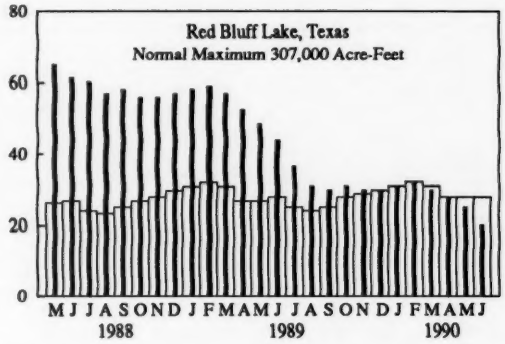
[4]Records of daily discharge computed jointly by Corps of Engineers and Geological Survey.

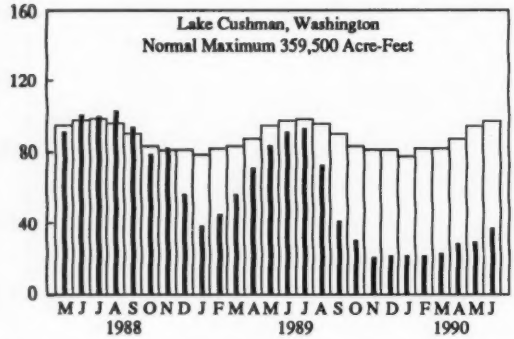
[5]Discharge determined from information furnished by Bureau of Reclamation, Corps of Engineers, and Geological Survey.

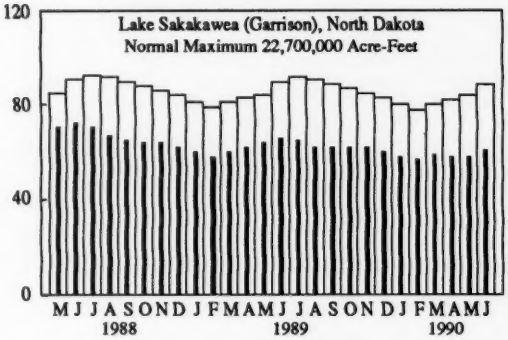
USABLE CONTENTS OF SELECTED RESERVOIRS AND RESERVOIR SYSTEMS

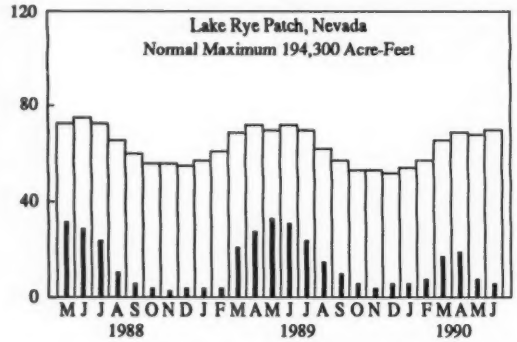


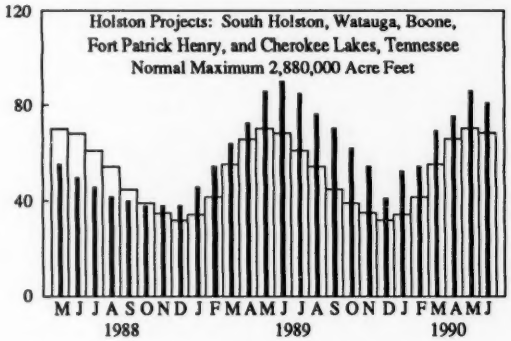
PERCENT OF NORMAL MAXIMUM

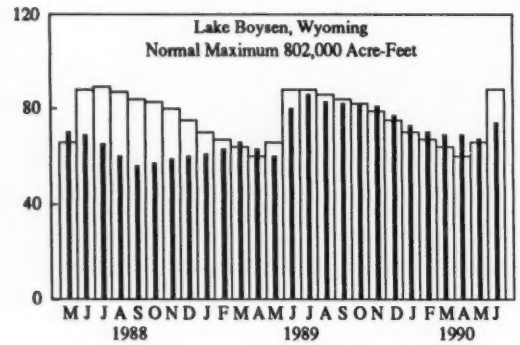


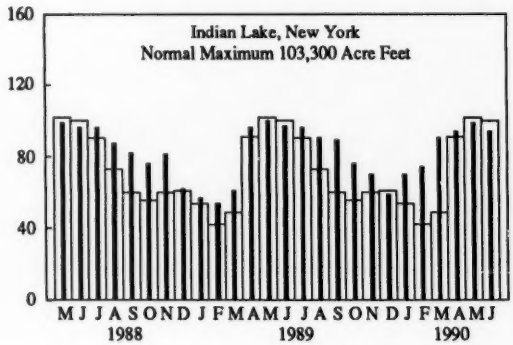



Lake Sakakawea (Garrison), North Dakota
Normal Maximum 22,700,000 Acre-Feet
120
80
40
0
M J J A S O N D J F M A M J J A S O N D J F M A M J
1988
1989
1990




Holston Projects: South Holston, Watauga, Boone,
Fort Patrick Henry, and Cherokee Lakes, Tennessee
Normal Maximum 2,880,000 Acre Feet
120
80
40
0
M J J A S O N D J F M A M J J A S O N D J F M A M J
1988
1989
1990





Provisional data; subject to revision

USABLE CONTENTS OF SELECTED RESERVOIRS NEAR END OF JUNE 1990

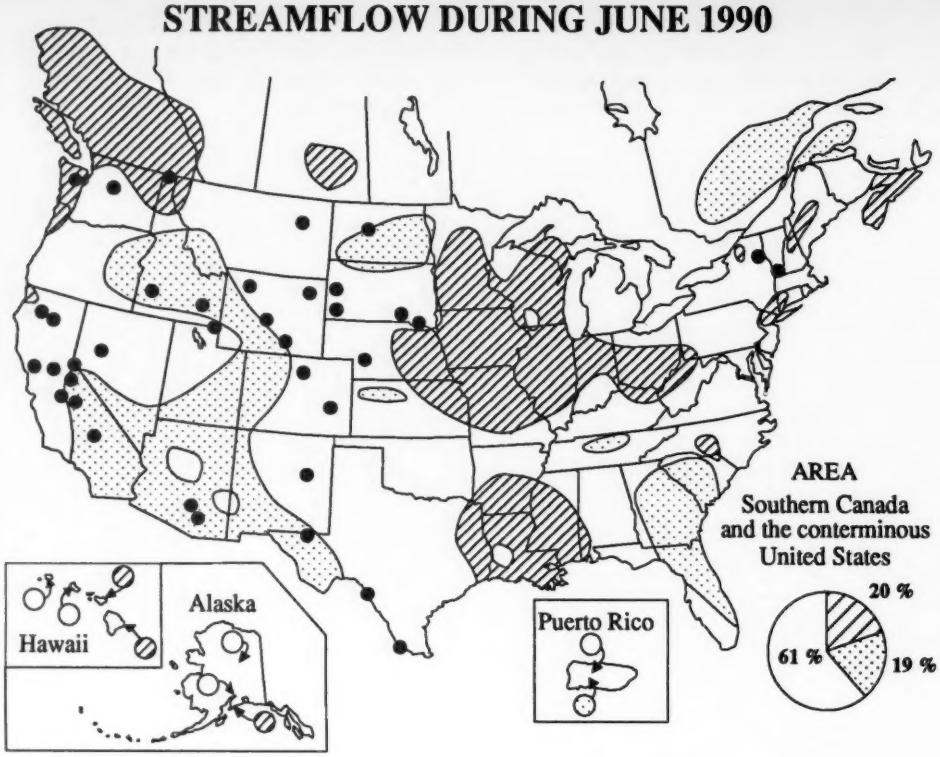
[Contents are expressed in percent of reservoir (system) capacity. The usable storage capacity of each reservoir (system) is shown in the column headed "Normal maximum"]

Reservoir Principal uses: F-Flood control I-Irrigation M-Municipal P-Power R-Recreation W-Industrial	Percent of normal maximum: End of June 1990	End of June 1989	Average for end of June	End of May 1990	Normal maximum (acre-feet)[a]
NOVA SCOTIA					
Rossignol, Mulgrave, Falls Lake, St. Margaret's Bay, Black, and Ponhook Reservoirs (P)	83	76	71	83	[b]226,300
QUEBEC					
Allard (P)	96	88	83	90	280,600
Gouin (P)	63	68	68	60	6,954,000
MAINE					
Seven Reservoir Systems (MP)	96	89	86	96	4,107,000
NEW HAMPSHIRE					
First Connecticut Lake (P)	94	87	90	87	76,450
Lake Francis (FPR)	96	91	87	94	99,310
Lake Winnipesaukee (PR)	100	98	96	108	165,700
VERMONT					
Harriman (P)	77	90	83	81	116,200
Somerset (P)	88	95	86	94	57,390
MASSACHUSETTS					
Cobble Mountain and Borden Brook (MP)	92	96	87	95	77,920
NEW YORK					
Great Sacandaga Lake (FPR)	95	99	92	101	786,700
Indian Lake (FMP)	94	97	100	99	103,300
New York City Reservoir System (MW)	96	100	96	100	1,680,000
NEW JERSEY					
Wanaque (M)	94	100	89	100	77,450
PENNSYLVANIA					
Allegheny (FPR)	49	70	49	49	1,180,000
Pymatuning (FMR)	97	105	97	99	188,000
Raystown Lake (FR)	68	67	63	68	761,900
Lake Wallenpaupack (PR)	82	75	84	88	157,800
MARYLAND					
Baltimore Municipal System (M)	98	99	92	99	261,900
NORTH CAROLINA					
Bridgewater (Lake James) (P)	95	95	91	93	288,800
Narrows (Badin Lake) (P)	91	95	96	100	128,900
High Rock Lake (P)	87	95	79	100	234,800
SOUTH CAROLINA					
Lake Murray (P)	90	93	31	91	1,614,000
Lakes Marion and Moultrie (P)	81	101	76	84	1,862,000
SOUTH CAROLINA-GEORGIA					
Strom Thurmond Lake (PP)	73	58	71	77	1,730,000
GEORGIA					
Burton (PR)	98	99	94	98	104,000
Sinclair (MPR)	88	84	89	88	214,000
Lake Sidney Lanier (FMPR)	62	62	63	65	1,686,000
ALABAMA					
Lake Martin (P)	97	98	92	97	1,375,000
TENNESSEE VALLEY					
Clinch Projects: Norris and Melton Hill Lakes (FPR)	72	82	61	79	2,293,000
Douglas Lake (FPR)	75	95	67	85	1,395,000
Hiwassee Projects: Chatuge, Nottely, Hiwassee, Apalachia, Blue Ridge, Ocoee 3, and Parksville Lakes (FPR)	87	95	80	89	1,012,000
Holston Projects: South Holston, Watauga, Boone, Fort Patrick Henry, and Cherokee Lakes (FPR)	81	90	68	86	2,880,000
Little Tennessee Projects: Nantahala, Thorpe, Fontana, and Chilhowee Lakes (FPR)	83	98	81	81	1,478,000
WISCONSIN					
Chippewa and Flambeau (PR)	94	92	87	93	365,000
Wisconsin River (21 Reservoirs) (PR)	86	82	81	82	399,000
MINNESOTA					
Mississippi River Headwater System (FMR)	45	45	39	44	1,640,000
NORTH DAKOTA					
Lake Sakakawea (Garrison) (FIPR)	61	66	89	58	22,700,000
SOUTH DAKOTA					
Angostura (I)	55	49	86	56	130,770
Belle Fourche (I)	51	59	71	61	185,200
Lake Francis Case (FIP)	80	80	87	83	4,589,000
Lake Oahe (FIP)	63	63	75	61	22,240,000
Lake Sharpe (FIP)	101	99	101	101	1,697,000
Lewis and Clark Lake (FIP)	82	80	95	80	432,000
NEBRASKA					
Lake McConaughy (IP)	65	73	80	70	1,948,000
OKLAHOMA					
Hufsmith (FPR)	102	103	97	122	2,378,000
Keystone (FPR)	102	101	104	110	661,000
Tenkiller Ferry (FPR)	111	99	102	123	628,200
Lake Altus (FIMR)	93	99	70	102	133,000
Lake O'The Cherokees (FPR)	104	96	95	112	1,492,000
OKLAHOMA-TEXAS					
Lake Texoma (FMPRW)	105	131	102	155	2,722,000
TEXAS					
Bridgeport (IMW)	99	100	57	100	386,400
Canyon (FMR)	95	95	88	100	385,600
International Amistad (FIMPW)	55	86	81	59	3,497,000
International Falcon (FIMPW)	36	61	65	48	2,668,000
Livingston (IMW)	100	109	92	104	1,788,000
Possum Kingdom (IMPRW)	94	99	97	94	570,200
Red Bluff (P)	20	44	28	25	307,000
Toledo Bend (P)	99	103	92	103	4,472,000
Twin Buttes (FIM)	46	67	34	48	177,800
Lake Kemp (IMW)	102	99	93	98	268,000
Lake Meredith (FMW)	41	42	37	37	796,900
Lake Travis (FIMPRW)	89	81	82	97	1,144,000
MONTANA					
Canyon Ferry (FIMPR)	90	77	93	75	2,043,000
Fort Peck (FPR)	62	69	88	61	18,910,000
Hungry Horse (FIPR)	95	86	93	81	3,451,000
WASHINGTON					
Ross (PR)	93	98	90	55	1,052,000
Franklin D. Roosevelt Lake (IP)	87	80	99	59	5,022,000
Lake Chelan (PR)	93	95	96	64	676,100
Lake Cushman (PR)	37	91	98	29	359,500
Lake Merwin (P)	105	106	104	106	245,600
IDAHO					
Boise River (4 Reservoirs) (FIP)	67	79	87	65	1,235,000
Coeur d'Alene Lake (P)	98	99	85	114	238,500
Pend Oreille Lake (FP)	91	95	97	76	1,561,000
IDAHO-WYOMING					
Upper Snake River (8 Reservoirs) (MP)	74	83	84	78	4,401,000
WYOMING					
Boysen (FIP)	74	80	88	67	802,000
Buffalo Bill (IP)	80	88	101	48	421,300
Keyhole (F)	25	30	49	27	193,800
Pathfinder, Seminoe, Alcova, Kortes, Glendo, and Guernsey Reservoirs (I)	49	56	68	46	3,056,000
COLORADO					
John Martin (FIR)	11	26	25	15	364,400
Taylor Park (IR)	94	94	93	70	106,200
Colorado-Big Thompson Project (I)	56	67	76	43	730,300
COLORADO RIVER STORAGE PROJECT					
Lake Powell; Flaming Gorge, Fontenelle, Navajo, and Blue Mesa Reservoirs (IFPR)	73	84	80	71	31,620,000
UTAH-IDAHO					
Bear Lake (IPR)	50	63	71	51	1,421,000
CALIFORNIA					
Folsom (FIP)	53	88	87	53	1,000,000
Hetch Hetchy (MP)	69	99	83	61	360,400
Isabella (FIR)	16	31	52	16	568,100
Pine Flat (FI)	28	21	70	32	1,001,000
Clair Engle Lake (Lewiston) (P)	66	78	90	62	2,438,000
Lake Almanor (P)	84	90	69	82	1,036,000
Lake Berryessa (FIMW)	46	59	83	48	1,600,000
Millerton Lake (FI)	64	65	81	68	503,200
Shasta Lake (FIPR)	55	69	85	51	4,377,000
CALIFORNIA-NEVADA					
Lake Tahoe (IPR)	12	25	73	11	744,600
NEVADA					
Rye Patch (I)	6	31	70	8	194,300
ARIZONA-NEVADA					
Lake Mead and Lake Mohave (FIMP)	78	83	75	79	27,970,000
ARIZONA					
San Carlos (IP)	3	24	25	3	935,100
Salt and Verde River System (IMPR)	42	67	50	47	2,019,100
NEW MEXICO					
Conchas (FIR)	61	69	84	61	315,700
Elephant Butte and Caballo (FIPR)	71	85	43	71	2,233,300

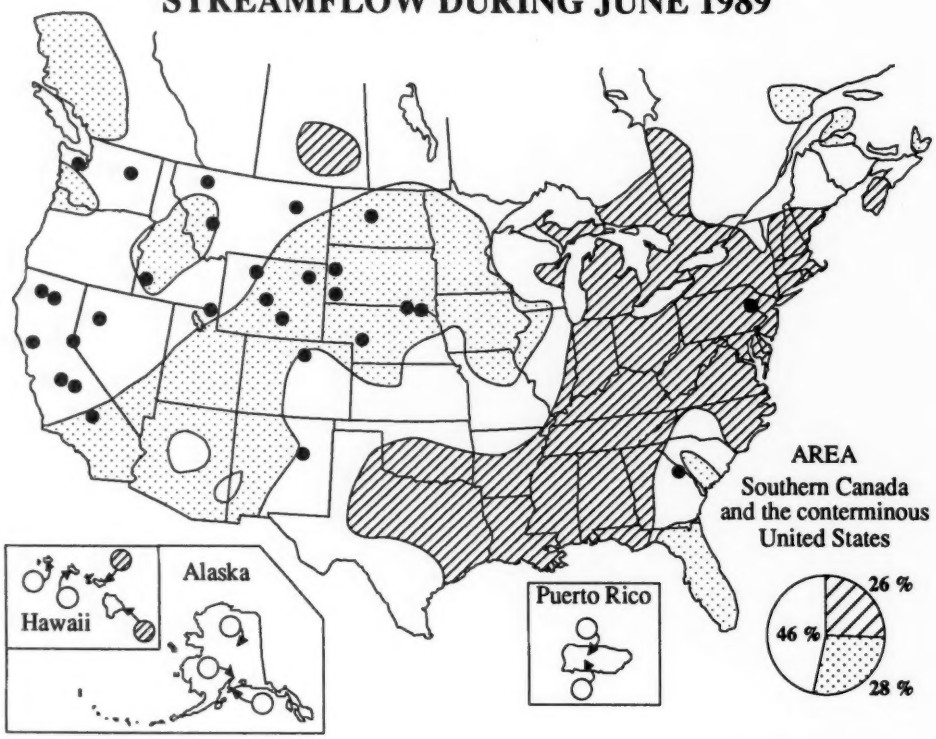
[a]1 acre-foot = 0.04356 million cubic feet = 0.326 million gallons = 0.504 cubic feet per second per day.

[b]Thousands of kilowatt-hours (the potential electric power that could be generated by the volume of water in storage).

STREAMFLOW DURING JUNE 1990



STREAMFLOW DURING JUNE 1989



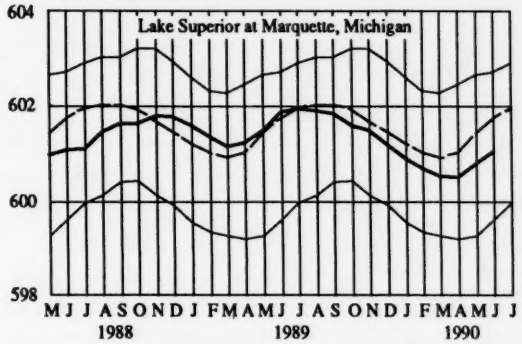
Above-normal range

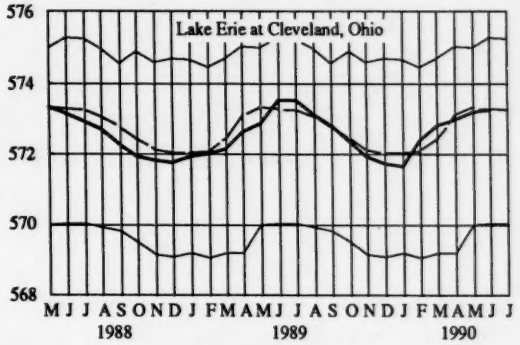
Below-normal range

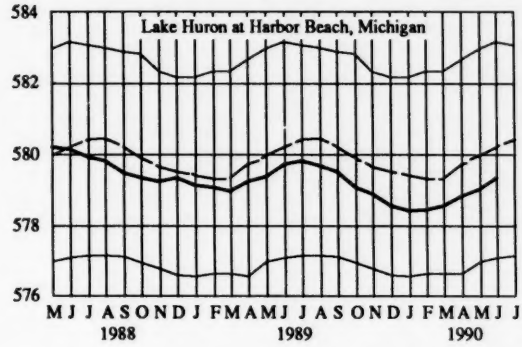
Below-average reservoir storage

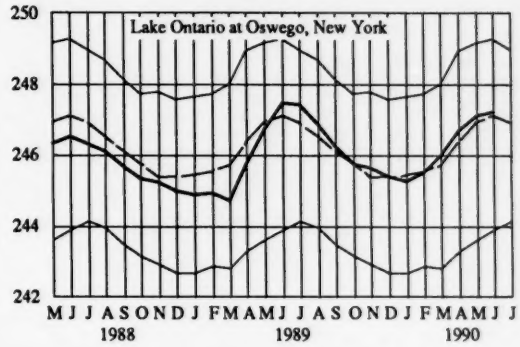
GREAT LAKES ELEVATIONS

Area between light-weight solid lines indicates range between highest and lowest record for the month. Dashed line indicates median of monthly values for reference period, 1951-80. Heavy line indicates mean for current period. Data from National Ocean Service.

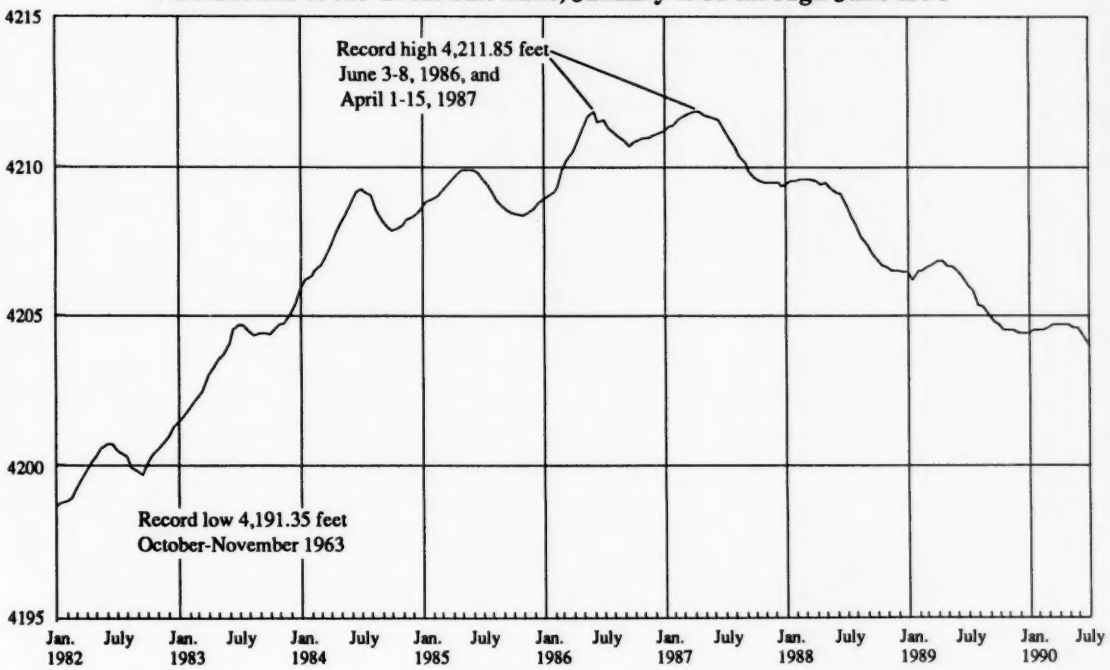




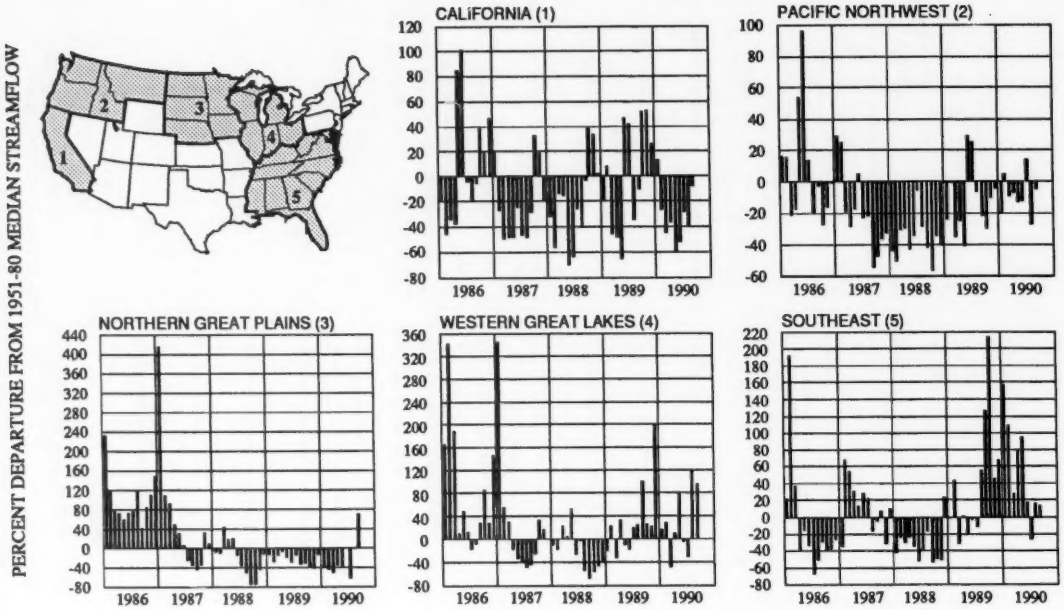




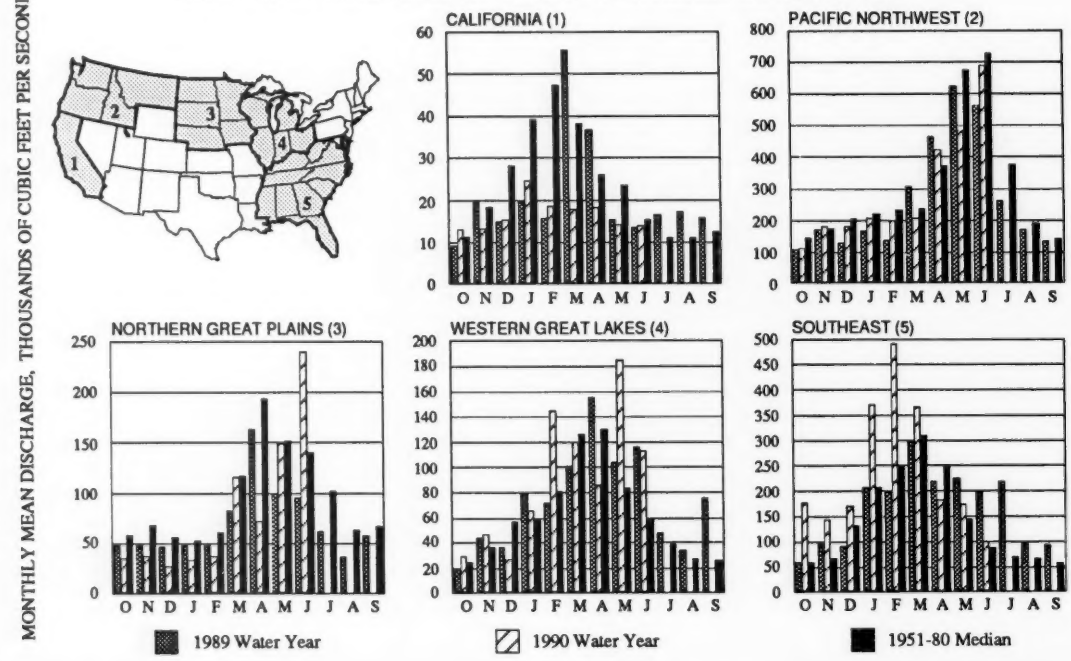
Fluctuations of the Great Salt Lake, January 1982 through June 1990



MONTHLY DEPARTURE OF ACTUAL STREAMFLOW (OCTOBER 1985-JUNE 1990) FROM MEDIAN STREAMFLOW (1951-80)

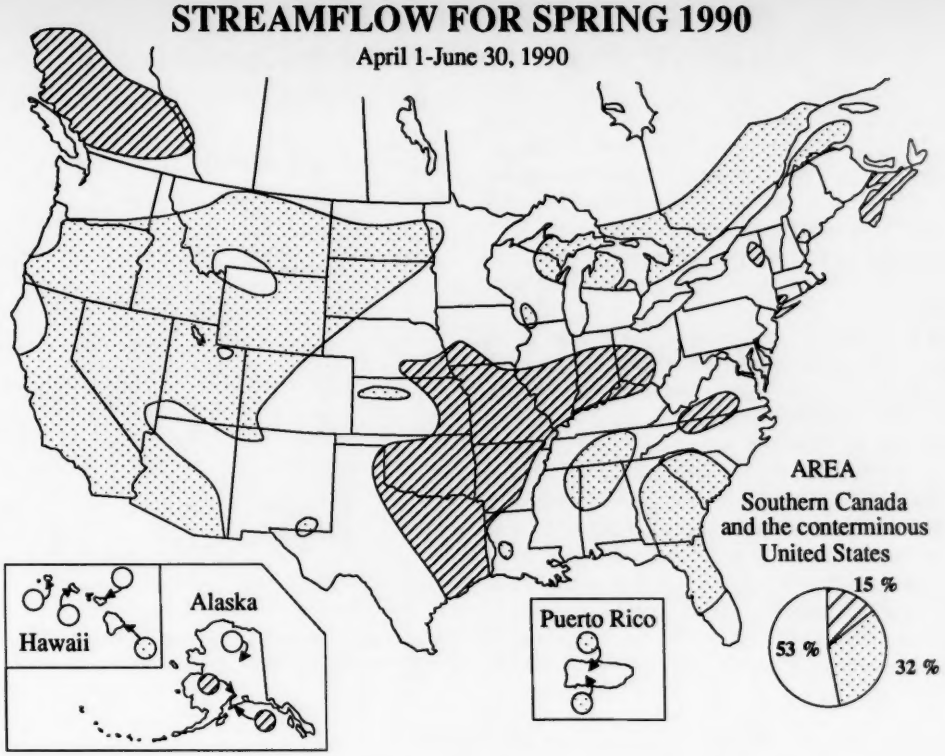


ACTUAL MONTHLY STREAMFLOW, 1989 AND 1990 WATER YEARS, COMPARED WITH MEDIAN MONTHLY STREAMFLOW, 1951-80



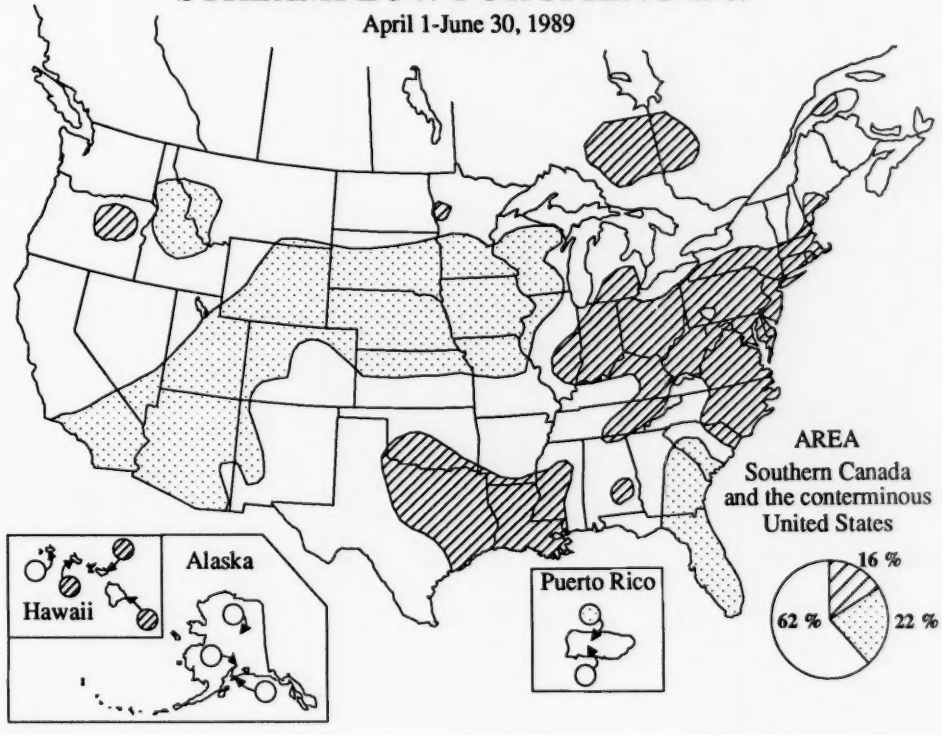
STREAMFLOW FOR SPRING 1990

April 1-June 30, 1990



STREAMFLOW FOR SPRING 1989

April 1-June 30, 1989

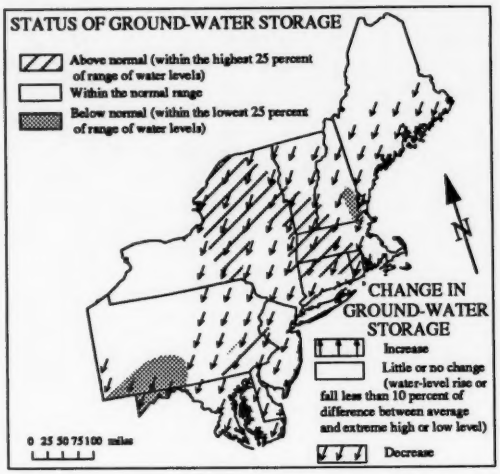


Above-normal range Normal range Below-normal range

GROUND-WATER CONDITIONS DURING JUNE 1990

Ground-water levels declined seasonally throughout most of the Northeast. (See map). Levels remained above average, however, in much of the central part of the Northeast including parts of New York, Vermont, Massachusetts, Connecticut, Rhode Island, and Pennsylvania. Below-average levels continued in the southwestern corner of the region and levels were also below normal in a small area in New Hampshire and Massachusetts.

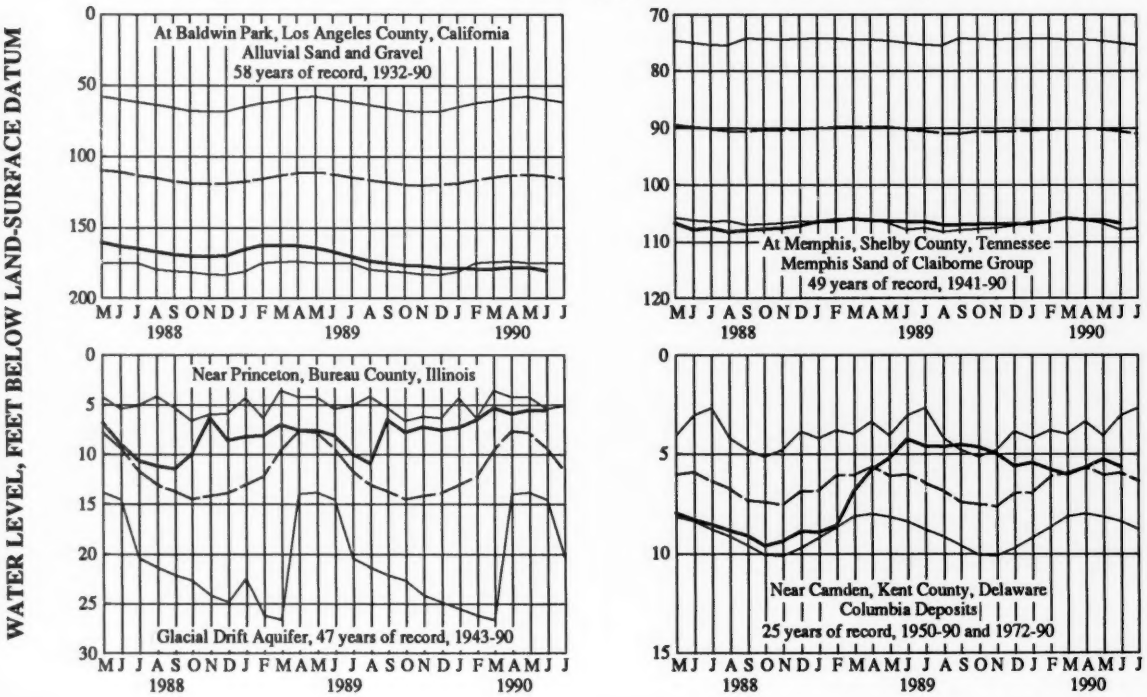
Ground-water levels declined seasonally in most of the Southeastern States, including most of West Virginia, Virginia, North Carolina, Louisiana, Mississippi, and Georgia. Levels rose in Arkansas and parts of Florida and were mixed with respect to last month in Kentucky. Water levels remained above average in most of West Virginia, Kentucky, Virginia, and North Carolina, were below average in Louisiana and Florida, near or below average in Georgia, and were mixed with respect to average in Arkansas. A June low occurred at the key well on Cockspur Island in the Savannah area of Georgia. New monthly highs occurred in key wells at Viola, Graves County, Kentucky; and Thelma, Louisa County, Virginia; despite declines in level since last month. An all-


STATUS OF GROUND-WATER STORAGE
Above normal (within the highest 25 percent of range of water levels)
Within the normal range
Below normal (within the lowest 25 percent of range of water levels)
N
CHANGE IN GROUND-WATER STORAGE
Increase
Little or no change (water-level rise or fall less than 10 percent of difference between average and extreme high or low level)
Decrease
0 25 50 75 100 miles

Map showing ground-water storage near end of June and change in ground-water storage from end of May to end of June.

MONTHEND GROUND-WATER LEVELS IN KEY WELLS

Area between light-weight solid lines indicates range between highest and lowest record for the month. Dashed line indicates average of monthly levels in previous years. Heavy line indicates level for current period.


WATER LEVEL, FEET BELOW LAND-SURFACE DATUM
At Baldwin Park, Los Angeles County, California
Alluvial Sand and Gravel
58 years of record, 1932-90
Near Princeton, Bureau County, Illinois
Glacial Drift Aquifer, 47 years of record, 1943-90
At Memphis, Shelby County, Tennessee
Memphis Sand of Claiborne Group
49 years of record, 1941-90
Near Camden, Kent County, Delaware
Columbia Deposits
25 years of record, 1950-90 and 1972-90
M J J A S O N D J F M A M J J A S O N D J F M A M J J
1988
1989
1990

time low occurred in Ruston, Jackson Parrish, Louisiana (15 years of record), and an all-time high occurred in Glenville, Gilmer County, Louisiana (36 years of record).

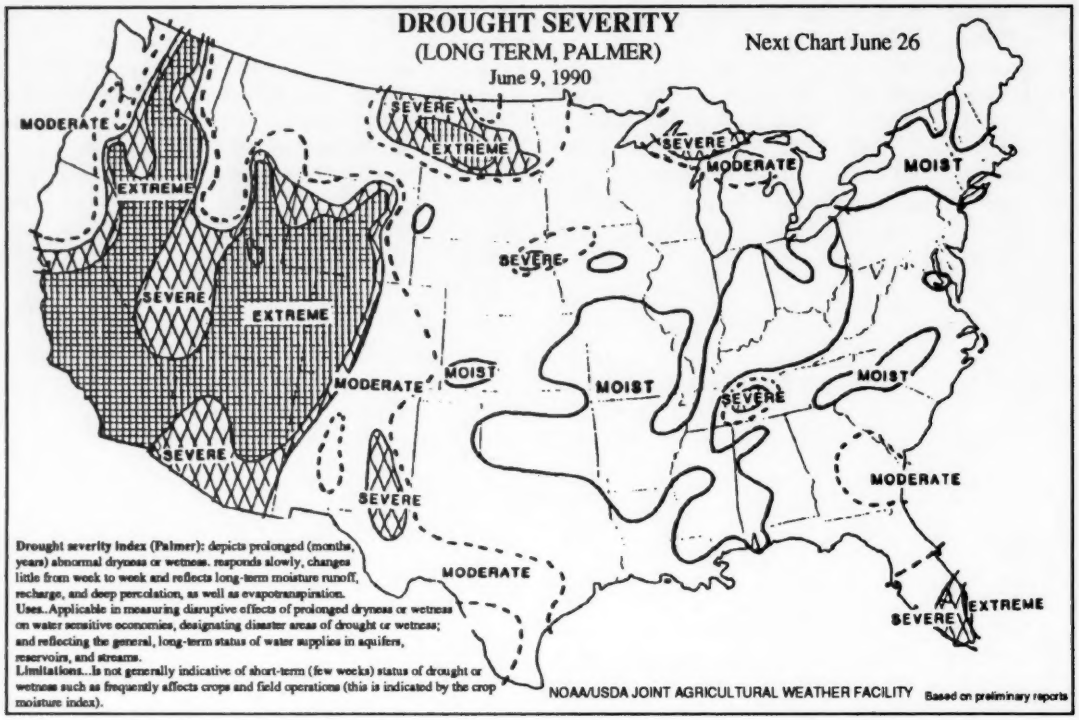
In the central and western Great Lakes States, ground-water levels rose Statewide in Wisconsin and Iowa, declined in Ohio, and were mixed with respect to last month in Minnesota and Michigan. Levels were below long-term averages in most of Minnesota and Wisconsin, above average in Iowa, and mixed with respect to average in Michigan and Ohio. A record high level occurred in the key well in Harcourt, Webster County, Iowa.

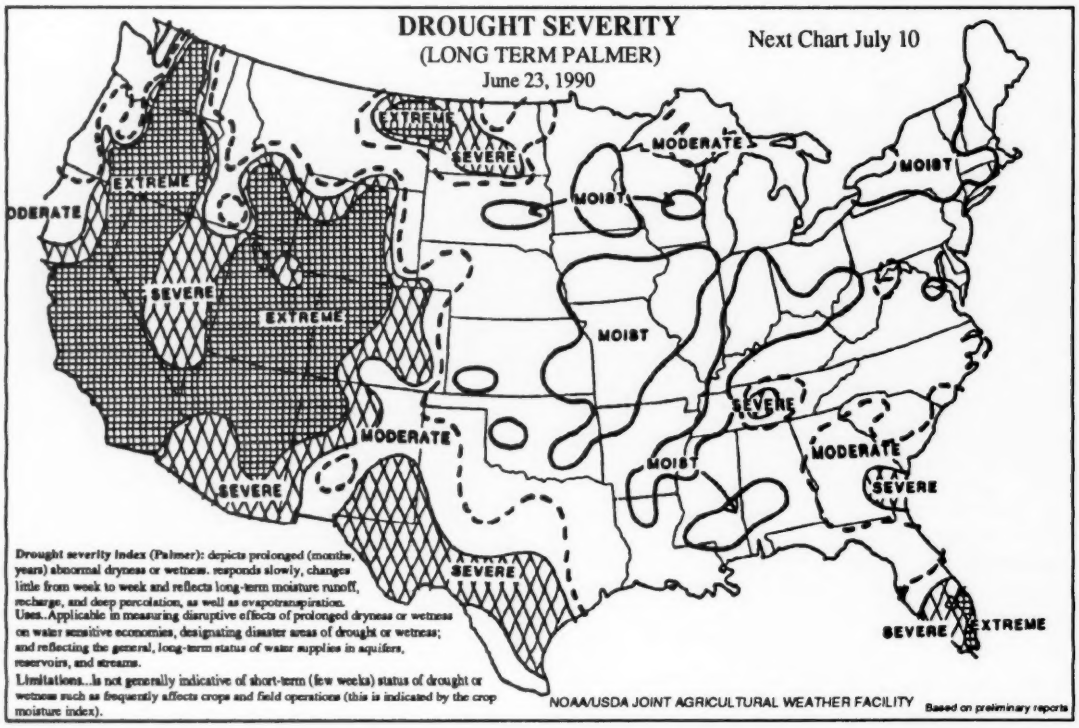
In the Western States, ground-water levels fell in most of New Mexico and Texas, but were mixed elsewhere with respect to last month. Levels remained below-average throughout most of the West. Record monthly lows occurred in key wells in Dickinson, Stark County, North Dakota; Baldwin Park, Los Angeles County, California; and Colby, Thomas County, Kansas. All-time record lows occurred in key wells in the Equus Beds at Halstead, Harvey County, Kansas (50 years of record); in the Edwards aquifer at San Antonio, Texas (57 years of record); and in the Hueco Bolson aquifer at El Paso, Texas (25 years of record).

Provisional data; subject to revision

WATER LEVELS IN KEY OBSERVATION WELLS IN SOME REPRESENTATIVE AQUIFERS IN THE CONTERMINOUS UNITED STATES–JUNE 1990

Aquifer and Location	Water level in feet with reference to land–surface datum	Departure from average in feet	Net change in water level in feet since: Last month	Net change in water level in feet since: Last year	Year records began	Remarks
Glacial drift at Hanska, south–central Minnesota	–3.75	+2.00	+6.75	+3.90	1942	
Glacial drift at Roscommon in north–central part of Lower Peninsula, Michigan.	–4.55	–0.33	–0.39	–0.47	1935	
Glacial drift at Marion, Iowa.....	–1.84	+2.44	+0.82	+4.48	1941	
Glacial drift at Princeton in northwestern Illinois.....	–5.55	+3.92	+0.04	+2.63	1943	
Petersburg Granite, southeastern Piedmont near Fall Zone, Colonial Heights, Virginia.	–14.35	+1.06	+0.13	–0.02	1939	
Glacial outwash sand and gravel, Louisville, Kentucky (U.S. well no. 2).	–17.66	+6.66	+0.53	+1.36	1946	
500–foot sand aquifer near Memphis, Tennessee (U.S. well no. 2).	–106.70	–16.12	–0.53	–0.24	1941	
Weathered granite, Mocksville area, Davie County, western Piedmont, North Carolina.	–15.11	+4.45	–1.50	+0.92	1932	
Sparta Sand in Pine Bluff industrial area, Arkansas ..	–228.20	–18.21	+10.55	+9.30	1958	
Eutaw Formation in the City of Montgomery, Alabama (U.S. well no. 4).	–25.5	–3.0	–1.3	–0.6	1952	
Upper Floridan aquifer on Cockspur Island, Savannah area, Georgia (U.S. well no. 6).	–38.97	–10.83	–3.11	–1.30	1956	June low
Sand and gravel in Puget Trough, Tacoma, Washington.	–101.96	+7.86	+0.37	+12.42	1952	
Pleistocene glacial outwash gravel, North Pole, northern Idaho (U.S. well no. 3).	–463.2	–3.5	+1.4	+4.1	1929	
Snake River Group: Snake River Plain Aquifer, at Eden, Idaho (U.S. well no. 4).	–122.5	–2.8	+2.6	+1.7	1957	
Alluvial valley fill in Flowell area, Millard County, Utah (U.S. well no. 9).	–37.29	+1.20	+1.87	–4.34	1929	
Alluvial sand and gravel, Platte River Valley, Ashland, Nebraska (U.S. well no. 6).	–5.65	–1.16	–0.02	+1.52	1935	
Alluvial valley fill in Steptoe Valley, Nevada.....	–7.77	+4.42	–0.78	–0.41	1950	
Pleistocene terrace deposits in Kansas River valley, at Lawrence, northeastern Kansas.	–20.44	–0.22	+1.45	+3.66	1953	
Alluvium and Paso Robles clay, sand, and gravel, Santa Maria Valley, California.	–155.00	–16.14	0	–8.25	1957	
Valley fill, Elfrida area, Douglas, Arizona (U.S. well no. 15).	–100.65	–16.92	+0.11	–0.76	1951	
Hueco bolson, El Paso area, Texas	–274.38	–20.74	–2.96	–0.69	1965	All-time low
Evangeline aquifer, Houston area, Texas	–302.65	–3.68	–1.45	–7.16	1965	


DROUGHT SEVERITY
(LONG TERM, PALMER)
June 9, 1990
Next Chart June 26
MODERATE
EXTREME
SEVERE
EXTREME
SEVERE
MODERATE
MOIST
SEVERE
EXTREME
SEVERE
MODERATE
MOIST
MOIST
SEVERE
MOIST
SEVERE
SEVERE
MODERATE
MODERATE
SEVERE
EXTREME
Drought severity index (Palmer): depicts prolonged (months, years) abnormal dryness or wetness. responds slowly, changes little from week to week and reflects long-term moisture runoff, recharge, and deep percolation, as well as evapotranspiration.
Uses..Applicable in measuring disruptive effects of prolonged dryness or wetness on water sensitive economies, designating disaster areas of drought or wetness; and reflecting the general, long-term status of water supplies in aquifers, reservoirs, and streams.
Limitations...Is not generally indicative of short-term (few weeks) status of drought or wetness such as frequently affects crops and field operations (this is indicated by the crop moisture index).
NOAA/USDA JOINT AGRICULTURAL WEATHER FACILITY
Based on preliminary reports


DROUGHT SEVERITY
(LONG TERM PALMER)
June 23, 1990
Next Chart July 10
EXTREME
SEVERE
MODERATE
MOIST
EXTREME
MOIST
SEVERE
EXTREME
MOIST
SEVERE
MODERATE
MOIST
MODERATE
SEVERE
SEVERE
SEVERE
EXTREME
Drought severity index (Palmer): depicts prolonged (months, years) abnormal dryness or wetness. responds slowly, changes little from week to week and reflects long-term moisture runoff, recharge, and deep percolation, as well as evapotranspiration.
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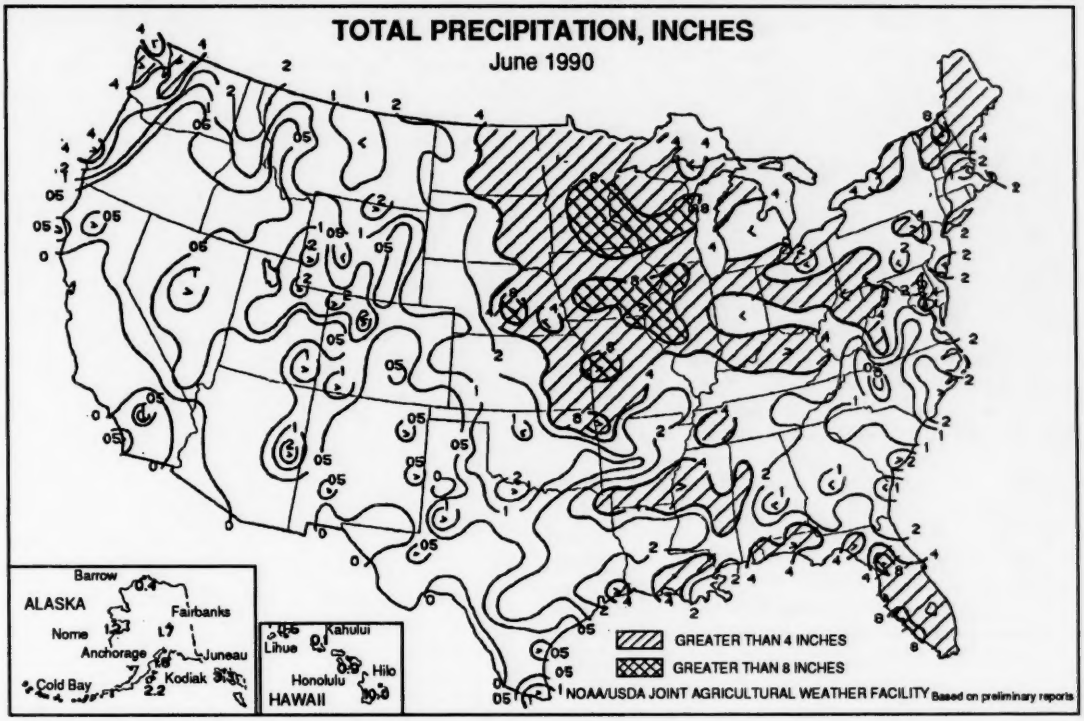
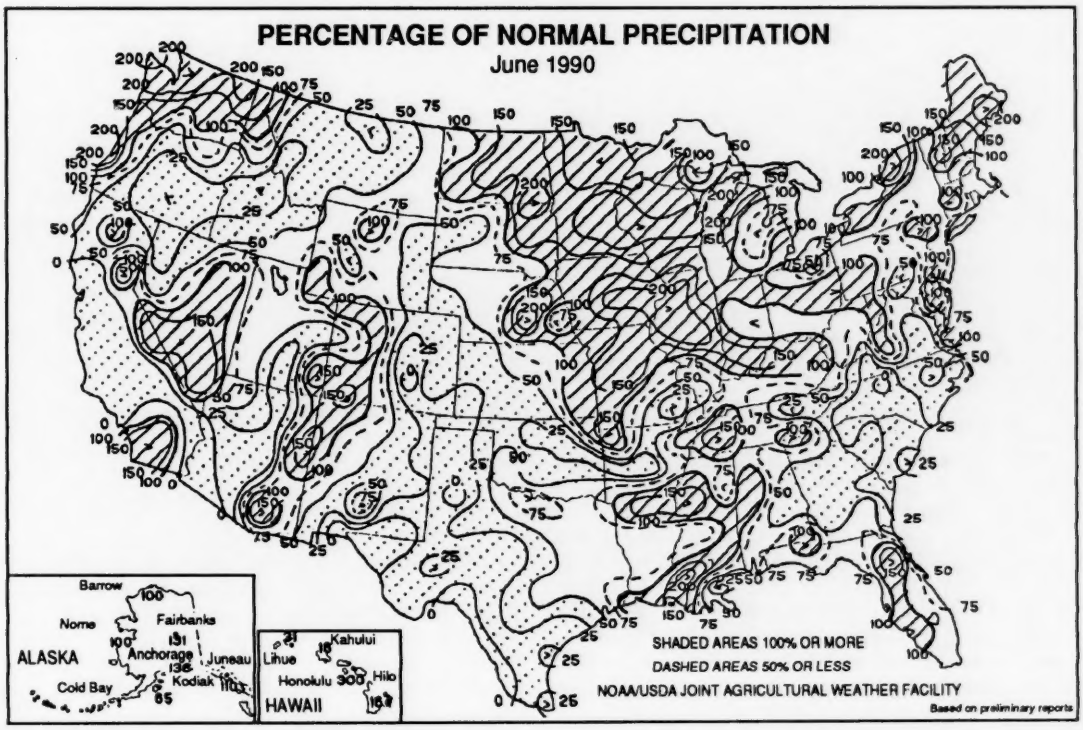
NOAA/USDA JOINT AGRICULTURAL WEATHER FACILITY
Based on preliminary reports

(From *Weekly Weather and Crop Bulletin* prepared and published by the NOAA/USDA Joint Agricultural Facility)

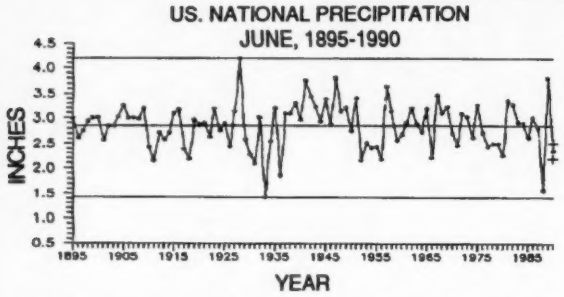




(From *Weekly Weather and Crop Bulletin* prepared and published by the NOAA/USDA Joint Agricultural Facility)

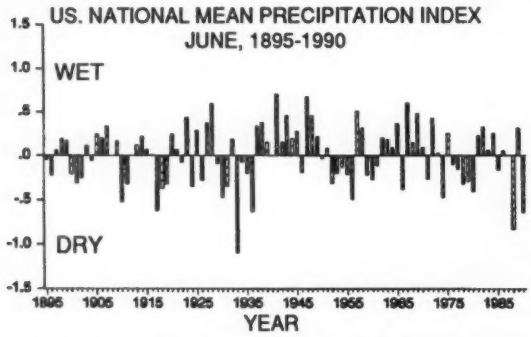
UNITED STATES JUNE CLIMATE IN HISTORICAL PERSPECTIVE

(From Climate Perspectives Branch, Global Climate Lab, NCDC, NOAA)



Areally-averaged precipitation for the nation was below the long-term (96-year) mean, ranking June 1990 as the 12th driest June on record. The preliminary value for precipitation is estimated to be accurate to within 0.16 inches and the confidence interval is plotted as a "+".

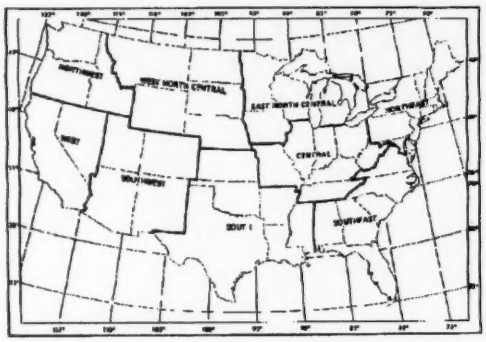
Historical precipitation is shown in a different way below. The June precipitation for each climate division in the country was first standardized using the gamma distribution over the 1951-80 period. These gamma-standardized values were then weighted by area and averaged to determine a national standardized precipitation value. Negative values are dry, positive are wet. This index gives a more accurate indication of how precipitation across the country compares to the local normal climate. The areally-weighted mean standardized national precipitation ranks June 1990 as the third driest June on record. The driest and second driest Junes were, respectively, 1933 and 1988.

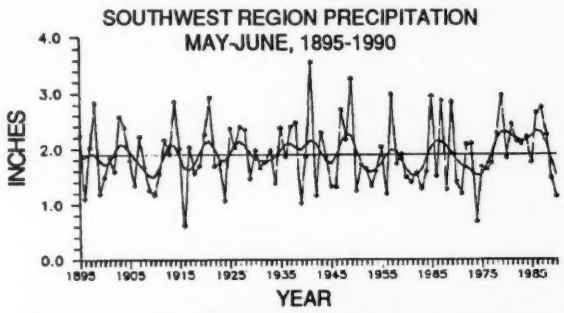


The unusual dryness in the southern regions, coupled with the hot temperatures in the southwestern United States, caused short-term (that is, monthly) moisture deficits across a considerable part of the country. The Palmer Z Index is a widely-used measure of short-term drought. Over 40 percent of the country experienced Z index values in the severe to extreme drought categories during June 1990. Only four other Junes (1933, 1934, 1936, and 1988) have experienced a greater area of short-term dryness.

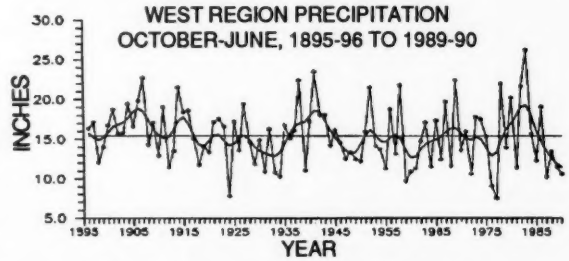
Considering the extreme short-term dryness of June, the percent of the nation experiencing long-term drought increased from its May 1990 value. A fourth of the country was in the severe to extreme long-term drought categories with only 12 other Junes having a larger area. Meanwhile, about a tenth of the country continued in the severely to extremely moist categories.

Temperatures in the Southwest region have been unusually warm for much of 1990. The April-June average temperature ranks 1990 as the third hottest such period on record. April through June has been consistently hotter than normal for the last six years. The extremely hot temperatures during 1990 in the Southwest region have been accompanied by unusually dry conditions, with May-June 1990 ranking as the sixth driest such period on record. This contrasts with the consistently wet conditions which occurred from the late 1970's to the late 1980's.





October-June precipitation for the West region ranks 1989-90 as the seventh driest such period on record, and marks the fourth consecutive such period with extremely dry conditions. Meanwhile, the Southeast region experienced the hottest January-June period on record in 1990. The unusual warmth contrasts sharply with the predominantly cold conditions which have occurred since the late 1950's.



The table below shows several statistics for the 18 river basins defined by the U.S. Water Resources Council and used by the National Weather Service Hydrological Service. The heavy rains in the East North Central region improved conditions for the basins in that area, while considerable drying has occurred in the basins draining Texas and New Mexico. There has been little change elsewhere, with the western basins continuing unusually dry.

January-June precipitation ranks 1990 as the ninth wettest. The last two years mark a return to the wetter-than-normal January-Junes

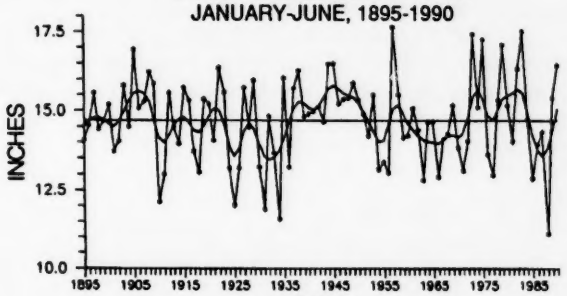
STATISTICS FOR SELECTED RIVER BASINS:
PRECIPITATION RANKING FOR OCT-JUN 1989-90, WHERE RANK OF 1 = DRIEST, 95 = WETTEST, BASED ON THE PERIOD 1895 TO 1990; AREAL PERCENT OF THE BASIN EXPERIENCING SEVERE OR EXTREME LONG-TERM (PALMER) DROUGHT; AND AREAL PERCENT OF THE BASIN EXPERIENCING SEVERE OR EXTREME LONG-TERM (PALMER) WET CONDITIONS, AS OF JUNE 1990.
(RIVER BASIN REGIONS AS DEFINED BY THE U.S. WATER RESOURCES COUNCIL.)

	PRECIPITATION	PERCENT AREA	
RIVER BASIN	RANK	DRY	WET
MISSOURI BASIN	40	32.7	3.7
PACIFIC NORTHWEST BASIN	32	36.8	3.1
CALIFORNIA RIVER BASIN	8	44.3	0
GREAT BASIN	18	52.4	0
UPPER COLORADO BASIN	2	100	0
LOWER COLORADO BASIN	22	92.2	0
RIO GRANDE BASIN	33	29.5	0
ARKANSAS-WHITE-RED BASIN	62	0	32.7
TEXAS GULF COAST BASIN	51	16.3	0
SOURIS-RED-RAINY BASIN	37	50.7	8.5
UPPER MISSISSIPPI BASIN	85	6.1	34.1
LOWER MISSISSIPPI BASIN	72	0	22.6
GREAT LAKES BASIN	67	0	12.7
OHIO RIVER BASIN	67	0	25.6
TENNESSEE RIVER BASIN	51	0	12.3
NEW ENGLAND BASIN	66	0	23.5
MID-ATLANTIC BASIN	64	0	9.0
SOUTH ATLANTIC-GULF BASIN	61	8.0	14.5

which dominated the early 1970's to mid-1980's, and contrast with the unusual dryness of the late 1980's (during which the driest January-June on record occurred [in 1988]).

In May 1988 the areal percent of the United States experiencing severe to extreme long-term drought surpassed 22%. The overall national drought area has been at or above that percentage for the last 26 months. This is the second longest time in this century that the country has been constantly afflicted by such a large area. Only the Great Drought of the 1950's has been so bad for so long.

US. NATIONAL PRECIPITATION
JANUARY-JUNE, 1895-1990



JUNE WEATHER SUMMARY

(From *Weekly Weather and Crop Bulletin* prepared and published by the NOAA/USDA Joint Agricultural Facility)

JUNE 1-2: Severe storms hit the Nation's mid-section with high wind, hail, and heavy rain. The worst tornado outbreak in Indiana since 1974 spawned at least 54 tornadoes within about 5 hours on June 2. Over 100 tornadoes struck throughout the Midwest on the same day. Meanwhile, a Pacific storm spread beneficial precipitation across the Northwest.

JUNE 3-9: The storm system that battered the Midwest moved rapidly eastward, producing severe weather across the Atlantic and Gulf Coast states. Thunderstorms erupted over Florida, causing severe weather but providing beneficial moisture. An intense thunderstorm pounded Beaumont, TX with 5.26 inches in only 2 hours on Monday. During the latter part of the week, strong thunderstorms developed along a frontal system reaching from the central Plains and across the middle Mississippi and Ohio Valleys. These storms caused inundating rains, large hail, and damaging winds. Up to 6 inches of rain drenched southern Indiana, causing severe flooding. The system soaked the middle Atlantic coast with more heavy rain at week's end. Remnants of Pacific Hurricane Boris brought unusual rainfall to southern California. San Diego, CA, received 0.87 inch on June 9 and 10, which is a June record for total rainfall. Hot weather prevailed across the Southwestern and South Central States as temperatures climbed daily into triple digits.

JUNE 10-16: At the start of the week, widely scattered showers and thunderstorm~ continued to develop in the warm and humid air covering much of the country. Generally beneficial showers dampened portions of the drought-stricken West, while a thunderstorm near Columbia, MS produced 3 inches of rain in 45 minutes and an early evening thunderstorm deluged Rogers, AR with 1 1/2 inches in 30 minutes. On Monday, severe thunderstorms developed in the upper Mississippi Valley ahead of a developing frontal system. The strong thunderstorms progressed southward and eastward through the week, spreading across the central Plains and Corn Belt. Thirty tornadoes produced damage in the upper Mississippi Valley and northern and central Plains. Warrensburg, MO was drenched with 4.5 inches on Thursday morning, while Shadyside, OH was inundated with 5.5 inches in 3 hours on Thursday night, causing a flash flood and at least 26 deaths. At week's end, torrential rains caused flooding across central Iowa.

JUNE 17-23: Scattered thunderstorms again developed in the warm, humid air covering the eastern half of the Nation, while hot, dry weather remained over the West and southern Plains. At the beginning of the week, a frontal system spread showers and thunderstorms from the eastern Corn Belt to the northern and middle Atlantic coast. Loganton, PA, was pounded with 3 inches of rain in 1 hour on Monday. Severe thunderstorms erupted over the northern and Central Plains on Tuesday morning, spawning tornadoes and producing large hail. On Wednesday, a frontal system developed over the central States and caused widespread showers and thunderstorms. Heavy rains drenched central Iowa to southern Indiana and southeastern Kansas to central Tennessee. At week's end, the system spread rain over the eastern third of the country as torrential rains caused flooding in parts of the upper Great Lakes, northern Florida, and New England. Excessive heat prevailed across the southern tier of States throughout the week as temperatures soared into the hundreds.

JUNE 24-30: Record heat and dry weather prevailed over the western half of the Nation as temperatures climbed into triple digits and high temperatures for the date were broken daily from California to the High Plains. All-time high temperature records were set at Lubbock, TX (110 degrees F), Tucson, AZ (117 degrees F), Pueblo, CO (108 degrees F), and Phoenix, AZ (122 degrees F). The Phoenix airport was temporarily closed because aircraft are not allowed to take off when temperatures are higher than 121 degrees F). Lubbock broke their June record of the number of 100-degree F days with 19. Cities with record-high temperatures for the month of June included Denver, CO with 102 degrees F and Scottsbluff, NE, with 106 degrees F. The heat wave spread into the Southeast, where record-high temperatures were set along the southern Atlantic seaboard at week's end.

Scattered showers and thunderstorms developed in the warm, humid air throughout the week across the Gulf Coast States, bringing needed moisture to Florida, eastern Texas, and Louisiana. On Monday, thunderstorms erupted in the upper Mississippi and lower Missouri Valleys, causing heavy rain. On Tuesday, severe thunderstorms, accompanied by large hail, damaging wind, and some tornadoes, spread from the northern Plains into the Northeast by week's end. These storms produced heavy rain and local flooding across the northern Corn Belt. Dry conditions remained along portions of the middle and southern Atlantic coast.

GROUND-WATER FLOW IN THE CENTRAL VALLEY, CALIFORNIA

The abstract and illustration are from the report, *Groundwater flow in the Central Valley, California*, by Alex K. Williamson, David E. Prudic, and Lindsay A. Swain, U.S. Geological Survey Professional Paper 1401-D, 127 pages, 1989. This report may be purchased for $28.00 from Books and Open-File Reports, U.S. Geological Survey, Box 25425 Federal Center, Denver, Colorado 80225 (check or money order payable to U.S. Geological Survey).

ABSTRACT

The agricultural productivity of the Central Valley is dependent on the availability of water from irrigation. About 7.3 million acres of cropland in the Central Valley receives about 22 million acre-feet of irrigation water annually. One half of this irrigation water is supplied by ground water, which amounts to about 20 percent of the Nation's ground-water pumpage. Ground water is important as a stable supply of irrigation water because of the high variability of surface-water supplies in the Central Valley. This large ground-water development during the past 100 years has had major impacts on the aquifer system, such as decline in water levels, land subsidence, depletion of the aquifer storage, and increase in recharge. The flow conditions before and during development were simulated on a regional scale using a three-dimensional finite-difference flow model.

The Central Valley is a large (20,000-square-mile) structural trough filled with poorly permeable marine sediments that are overlain by coarser continental sediments. In general, previous investigators have conceptualized the northern one-third of the valley—the Sacramento Valley—as a water-table aquifer and the southern two-thirds—the San Joaquin Valley—as a two-aquifer system separated by a regional confining clay layer. A somewhat different concept of the aquifer system was suggested during this study by analyses of water-level measurements, texture of sediments interpreted from electric logs, and flow-model simulations. Vertical hydraulic head differences are found throughout much of the Central Valley. Early in development, flowing wells and marshes were found throughout most of the central part of the valley. More than 50 percent of the thickness of the continental sediments is composed of fine-grained lenticular deposits that are discontinuous but are distributed throughout the stratigraphic section in the entire Central Valley.

The concept presented in this report considers the entire thickness of the continental deposits as one aquifer system which has varying vertical leakance that depends on several factors, including amount of fine-grained sediments. The average horizontal hydraulic conductivity is about 6 feet per day, and the average thickness of the continental deposits is about 2,400 feet.

Irrigation use, which averaged 22 million acre-feet of water per year during 1961-77, increased evapotranspiration about 9 million acre-feet per year over its predevelopment value. This is a large figure compared with the average annual surface-water inflow to the Central Valley of 31.7 million acre-feet per year. Precipitation on the valley floor is mostly lost to evapotranspiration. The overall postdevelopment recharge and discharge of the aquifer system was about 6 times greater than the predevelopment estimated values. The increases of pumpage associated with development mostly in the San Joaquin Valley have caused water-level declines that exceed 400 feet in places and have resulted in the largest known volume of land subsidence due to fluid withdrawal in the world. Water in aquifer storage declined about 60 million acre-feet from predevelopment to 1977; 40 million acre-feet were derived from the water-table zone, 17 million acre-feet from compaction of sediments, and 3 million acre-feet from elastic storage. During 1961-77, ground water withdrawn from aquifer storage averaged about 800,000 acre-feet per year.

The flow model constructed during this study was calibrated principally in accordance with the hydrologic data observed during 1961-75 because little predevelopment data were available for analysis. An explicit algorithm to simulate land subsidence was developed and calibrated. The simulated land subsidence was within 6 percent of the estimated observed volume; however, the time lag associated with this type of subsidence was not adequately simulated. Simulated water-level changes averaged 2.6 and 12 feet higher than observed water-level changes for the water table and the lower pumped zones, respectively, and the standard deviation of the simulated changes minus the observed change was 22 and 27 feet, respectively. The flow model was tested for the period of 1976-77 drought with good results. The simulations indicated that vertical leakance greatly increased from the predevelopment values as a result of water flowing through some of the more than 100,000 irrigation well casings that are open to different aquifer layers.

The simulation results are shown on maps for comparison with observed hydrologic data. A description of the computer-tape file, which contains estimates of recharge/discharge, and the aquifer properties used in the simulation are included in appendix A and B, respectively. The theoretical basis of calculating borehole hydraulic conductance of multilayer wells which cause increases in vertical leakance during the post-development period is discussed in appendix C.

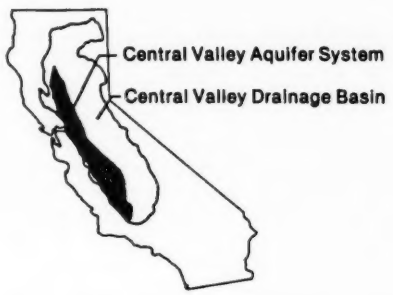
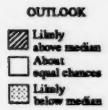


Figure 1.-Location of the Central Valley, California

TEMPERATURE OUTLOOK FOR JULY-SEPTEMBER 1990



PRECIPITATION OUTLOOK FOR JULY-SEPTEMBER 1990

NATIONAL WATER CONDITIONS

JUNE 1990

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EXPLANATION OF DATA (Revised December 1989)

Cover map shows generalized pattern of streamflow for the month based on provisional data from 186 index gaging stations—18 in Canada, 166 in the United States, and 2 in the Commonwealth of Puerto Rico. Alaska, Hawaii, and Puerto Rico inset maps show streamflow only at the index gaging stations that are located near the point shown by the arrows. Classifications on map are based on comparison of streamflow for the current month at each index station with the flow for the same month in the 30-year reference period, 1951-80. Shorter reference periods are used for one Canadian index station, two Kansas index stations, and the Puerto Rico index stations because of the limited records available.

The ***streamflow ranges map*** shows where streamflow has persisted in the above- or below-normal range from last month to this month and also where streamflow is in the above- or below-normal range this month after being in a different range last month. Three ***pie charts*** show: the percent of stations reporting discharges in each flow range for both the conterminous United States and southern Canada, and also the percent of area in each flow range for the conterminous United States and southern Canada. The ***bar graph*** shows total mean and total median flow for all reporting stations in the conterminous United States and southern Canada.

The comparative data are obtained by ranking the 30 flows for each month of the reference period in order of decreasing magnitude—the highest flow is given a ranking of 1 and the lowest flow is given a ranking of 30. Quartiles (25-percent points) are computed by averaging the 7th and 8th highest flows (upper quartile), 15th and 16th highest flows (middle quartile and median), and the 23rd and 24th highest flows (lower quartile). The upper and lower quartiles set off the highest and lowest 25 percent of flows, respectively, for the reference period. The median (middle quartile) is the middle value by definition. For the reference period, 50 percent of the flows are greater than the median, 50 percent are less than the median, 50 percent are between the upper and lower quartiles (in the normal range), 25 percent are greater than the upper quartile (above normal), and 25 percent are less than the lower quartile (below normal). Flow for the current month is then classified as: in the ***above-normal range*** if it is greater than the upper quartile, in the ***normal range*** if it is between the upper and lower quartiles, and in the ***below-normal range*** if it is less than the lower quartile. Change in flow from the previous month to the current month is classified as ***seasonal*** if the change is in the same direction as the change in the median. If the change is in the opposite direction of the change in the median, the change is classified as ***contraseasonal*** (opposite to the seasonal change). For example: at a particular index station, the January median is greater than the December median; if flow for the current January increased from December (the previous month), the increase is seasonal; if flow for the current January decreased from December, the decrease is contraseasonal.

Flood frequency analyses define the relation of flood peak magnitude to probability of occurrence or recurrence interval. ***Probability of occurrence*** is the chance that a given flood magnitude will be exceeded in any one year. ***Recurrence interval*** is the reciprocal of probability of occurrence and is the average number of years between occurrences. For example, a flood having a probability of occurrence of 0.01 (1 percent) has a recurrence interval of 100 years. ***Recurrence intervals imply no regularity of occurrence***; a 100-year flood might be exceeded in consecutive years or it might not be exceeded in a 100-year period.

Statements about ***ground-water levels*** refer to conditions near the end of the month. The water level in each key observation well is compared with average level for the end of the month determined from the 30-year reference period, 1951-80, or from the entire past record for that well when only limited records are available. Comparative data for ground-water levels are obtained in the same manner as comparative data for streamflow. ***Changes in ground-water levels***, unless described otherwise, are from the end of the previous month to the end of the current month.

Dissolved solids and temperature data are given for five stream-sampling sites that are part of the National Stream Quality Accounting Network (NASQAN). ***Dissolved solids*** are minerals dissolved in water and usually consist predominately of silica and ions of calcium, magnesium, sodium, potassium, carbonate, bicarbonate, sulfate, chloride, and nitrate. ***Dissolved-solids discharge*** represents the total daily amount of dissolved minerals carried by the stream. ***Dissolved-solids concentrations*** are generally higher during periods of low streamflow, but the highest dissolved-solids discharges occur during periods of high streamflow because the total quantities of water, and therefore total load of dissolved minerals, are so much greater than at times of low flow.

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